

The AMSAT[®] Journal

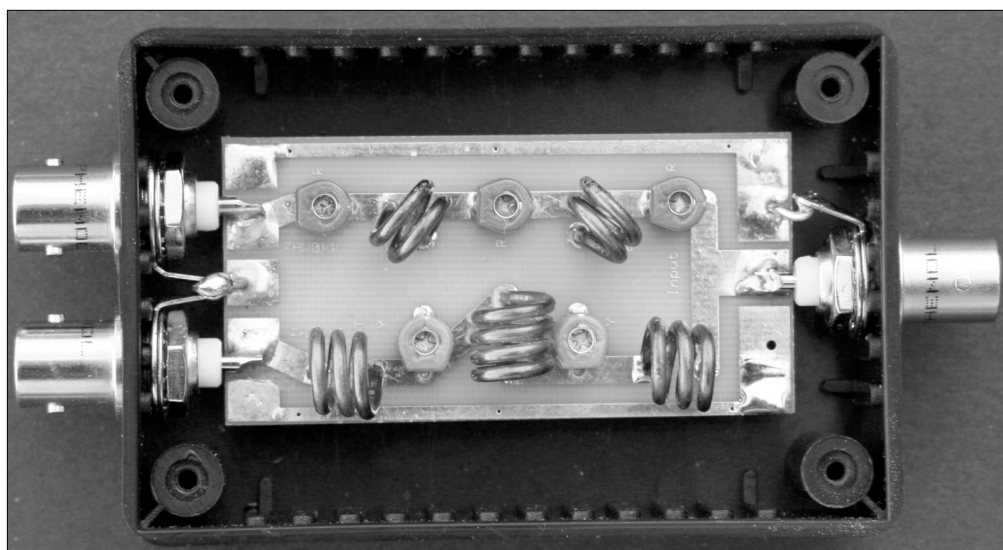


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Volume 32, Number 6

November/December 2009



Build your own diplexer



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A codicil in your will, naming The Radio Amateur Satellite Corporation as a beneficiary will help insure the continuance of the Amateur Radio Satellite program.

Call the AMSAT-NA office at 301-589-6062 for questions on any or all of these ways you can help build new and exciting satellites.

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AMSAT Announcements

Chinese XW-1 Satellite Designated HO-68

Based upon a successful launch of the Chinese XW-1 Amateur Radio satellite on 15 December from the Taiyuan Satellite Launch Center of China, on a CZ-4C rocket and since amateurs around the world have received beacon signals from XW-1, a request has been made that an OSCAR number be allocated to this spacecraft. Further, XW-1 has been coordinated through IARU Amateur Satellite Frequency Coordination Panel.

Bill Tynan, W3XO, stated that "As XW in Chinese means "hope", it had been requested that this word be used as the prefix for the new OSCAR number. Therefore, with the above information and the authority vested in me by the AMSAT-NA President, I hereby designate this latest Amateur Radio satellite as Hope Oscar 68 or HO-68."

W3XO continues "On behalf of AMSAT-NA and the world's Amateur Radio satellite community, I congratulate those responsible for building, testing and launching this new satellite. May it have a long and successful life." 🌐

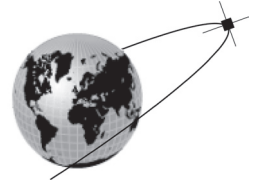
AMSAT's Mission

AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision

Our Vision is to deploy satellite systems with the goal of providing wide-area and continuous coverage. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.





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Moving Forward....

Since writing my previous Apogee View column, much has happened that needs to be shared with you. A number of announcements were made at the AMSAT Symposium concerning AMSAT's future direction as well as providing a status report on the organization itself. Now is a good time to update you on recent events.

AMSAT Lab

An ANS news release was published over the Thanksgiving holiday weekend providing details on the negotiated settlement with the defendants. That announcement is on our Web site (www.amsat.org). Under the agreement, AMSAT received \$19,000.00 in exchange for leaving the AMSAT Lab 'as is, where is'. As noted in the news release, I am pleased that we now have this difficult circumstance behind us, allowing AMSAT to move forward on future opportunities.

I'd like to extend a grateful 'Thank You!' to Rick Hambly, W2GPS, and Bob Davis, KF4KSS, for their significant efforts to deal with this situation. Rick's willingness to work through this process on AMSAT's behalf was invaluable as he was the key individual who negotiated the original agreement with University of MD Eastern Shore (UMES) and MDHawk, and knew the individuals with these organizations as well as the history of the relationship. Bob Davis served as our lab manager and following his resignation from HISS, managed the process of placing our equipment in storage and keeping tabs on the equipment there. Both individuals provided significant counsel during the negotiations that took place on October 20th. I am indebted to both of them for their efforts to bring about as good a conclusion to this process as one might expect.

Looking forward ... We announced at the AMSAT Symposium that AMSAT is 'in conversation' with the University of Florida (UF), Gainesville concerning establishing a new AMSAT Lab on their campus. Those conversations are continuing with UF providing AMSAT with a draft Memorandum of Understanding (MOU). We are in the process of having the same attorney who handled our AMSAT lab litigation advise us on this draft. Clearly, we want to ensure that the lessons learned from our just concluded experience are incorporated into any future relationship

with a university. That said, I believe that the conversations we're having with UF have so far revealed a significantly different attitude and set of expectations than what we found with UMES. The University of Florida has an ongoing small satellite program and my impression is that UF is focused on specific student opportunities in small satellites. They are anxious to incorporate AMSAT's expertise into their program while providing AMSAT with resources to help us develop and build future satellites. If negotiations are successfully concluded, I expect this new relationship to be a 'win-win' for all concerned. Stay tuned!

Moving forward During the BoD meeting that took place at the time of the annual meeting in Maryland, Alex Harvilchuck, N3NP, of the IBM Systems Engineering Center made a presentation concerning engineering students at the State University of New York - Binghamton working on a next generation CubeSat design. The board endorsed a relationship with SUNY-Binghamton to encourage such a project with the understanding that AMSAT would provide advisors to assist the four engineering teams working on the project as their senior engineering capstone project.

On November 18th a NextGen CubeSat Power & Structure Systems Preliminary Design Review teleconference was held with SUNY engineering students and their faculty advisors. AMSAT VP-Engineering Tony Montiero, AA2TX, ARISS Hardware Manager Lou McFadin, W5DID, and I represented AMSAT on the call. Tony and Lou provided significant technical feedback that was appreciated by the SUNY participants. This is an opportunity not only for AMSAT to gain the benefit of working with very bright engineering students who have some excellent ideas on developing spacecraft, but it is also a learning experience for AMSAT in developing relationships with university engineering programs and expanding our educational outreach. I am hopeful that as we gain experience in nurturing these opportunities, we will work with other universities (such as UF) on senior projects that have potential benefit for AMSAT engineering while providing hands

continued on page 7 ...



ETP CubeSat Simulator (Part 2, the Classroom Activity Part)

by Mark Spencer, WA8SME, mspencer@arrl.org

ARRL Education and Technology Program Coordinator

In Part One of this article, I described the technical side of a CubeSat Simulator that can serve as a classroom resource for teachers who want to include and introduce the fundamentals of satellite operations into a portfolio of space related classroom activities. The CubeSat Simulator includes an operating satellite model, UHF data link module, ground station receiver with display software for the transmitted telemetry, and a rotator mounting harness to hold the satellite (Figure 15). It was suggested that the CubeSat Simulator might be a valuable addition to your satellite demonstrations at hamfests or club meetings to give your audience a visual of satellite operations as well as give you a prop that can stimulate conversations about ham radio satellites.

In this second part of the article, I will briefly describe an expanded list of classroom activities that come to mind for the CubeSat Simulator.

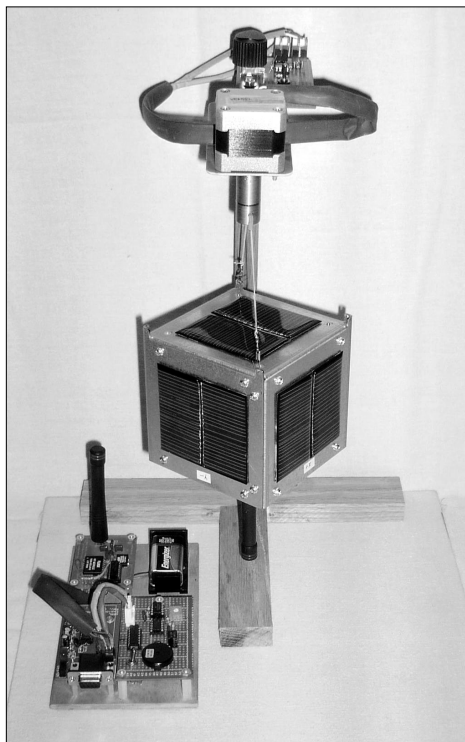


Figure 15: CubeSat Simulator system.

Elementary Level

Build a model of a satellite. Using the satellite shell as a template, students construct satellite models out of construction paper or other material and draw component features to populate their satellite surfaces as their imaginations dictate. Part of this activity would include listening to audio files of

the original Sputnik satellite transmissions and comparing those transmissions to the telemetry transmissions of today's technology. The students further study the history of space travel to date by developing a timeline depiction of major milestones in the quest to explore space. During the class period, have satellite tracking software operating in the background and monitor satellite transmissions as the birds come over the horizon.

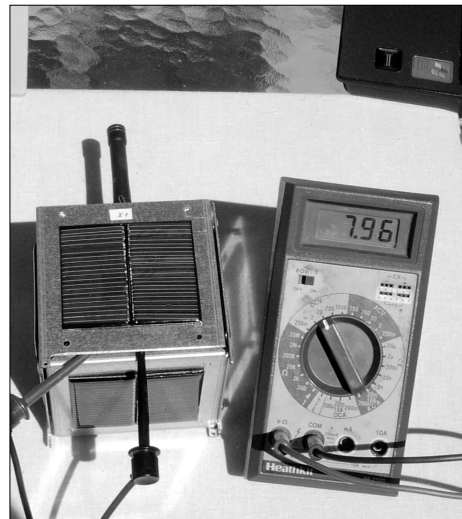


Figure 16: Voltage measurement setup.

Basic Electronics, System Calibration and Parameters

How much current does the CubeSat Simulator draw during operation? (Answer: transmitting CW: 26 mA, transmitting data: 21 mA, at rest: 19 mA)

What is the minimum panel/battery voltage required for the CubeSat Simulator to operate? (Answer: approximately 3.8 volts)

What is the relationship between analog to digital converter (ADC) value and the voltage that value represents? In this activity the students would use a VOM to measure the voltage on a solar panel and collect a data set of ADC values that the simulator transmits at that voltage. The students would have to figure out a way to control the voltage output of the panel (by restricting the amount of light hitting the panel is probably the easiest way, Figures 16 and 17). Once the data set is collected, it is graphed to illustrate the relationship between ADC and voltage (Figure 18).

How does the angle between the solar panel

and the Sun affect the current produced by the solar panel? In this activity the students would have to come up with some sort of jig to allow them to vary and measure the angle between the panel surface and the illuminating source (Sun) and then using a VOM and a 100 ohm load, measure the current. The current is plotted as a function of angle away from nadir (Figure 21).

The pictures (Figures 19 and 20) illustrate one way of accomplishing this activity. A protractor is taped to a side of the satellite. A straw, or in this case a skewer, is taped between the panels to create a shadow across the protractor to give a measurement of the angle relative to nadir.

Satellite Operation Activities

How long will the satellite operate in eclipse? (Answer: approximately 7 minutes) For this activity the students start with a fully charged satellite and then operate it without illumination (covered) and determine the time before the satellite transmission stops. They will probably note that toward the end of the usable transmission time that the reported ADC voltages become erratic.

How can you use the telemetry data to determine the rotation rate of the satellite? This activity involves interpreting the ADC plots of the panel voltages and determining the period of the displayed sine waves. The simulator rotator is set to various rotation rates and the students use the collected data to determine the rate of rotation.

How can you use the telemetry data to determine the tilt off-axis of the satellite? This activity involves comparing the



Figure 17: Panel voltage varied by covering up the panel to limit illumination in steps.

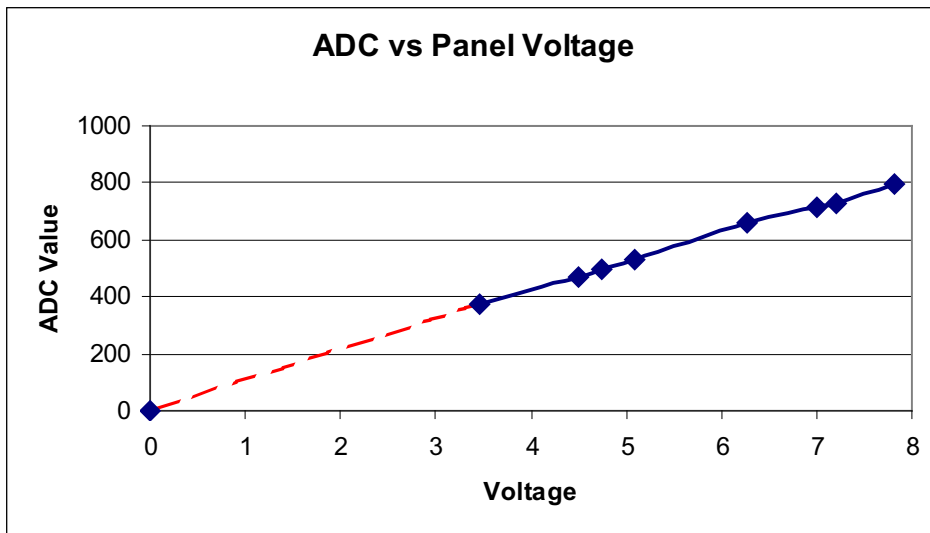


Figure 18: Excel generated graph of voltage vs. ADC value.

collected Z axis data when the satellite is vertical versus when tilted in the harness. When vertical, the Z axis data is virtually flat indicating a constant angle between the Z axis panels and the illumination source. When tilted off nadir, the angle between the Z axis panels and the illumination source varies with the characteristic sine curve. A more advanced exploration would be to use the data to quantify the angle of tilt.

How can you use the telemetry data to troubleshoot a problem with the satellite, for instance, a degraded solar panel? In this activity one of the solar panels is degraded to simulate a problem, in the example here, the panel is simply covered up temporarily. Using the collected data, the students determine what the problem might be and can speculate possible solutions.

What is the minimum number of data points needed to get an accurate picture of the parameter being measured? This activity is actually exploring some concepts borrowed from digital signal processing techniques; the Nyquist frequency or rate and aliasing.

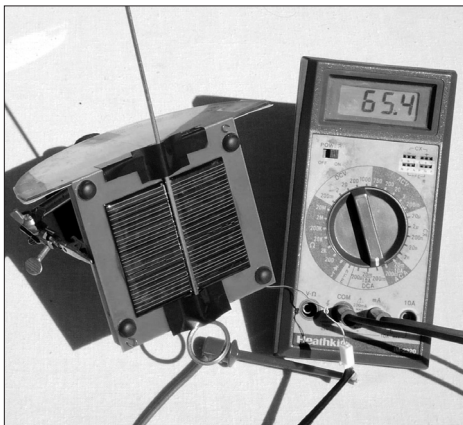


Figure 19: Current measurement setup.

There is significant power consumed by the satellite to transmit the telemetry data, and it is prudent to limit the amount of data transmitted to the minimum rate required to send accurate information to conserving power for other purposes. To obtain accurate information about a waveform (in this case the voltage produced by solar panels on a rotating satellite), the waveform must be sampled at a rate of at least twice the frequency of the wave (the Nyquist frequency). The waveform produced by the panels in the simulator is a nice smooth sine wave therefore we should be able to sample the panels at a minimum rate of twice the rotation rate of the satellite and still be able to recover the information about the waveform without degradation. Sampling the waveform at a high rate will produced more detailed information, but in many cases the added information would be redundant and power wasteful.

In this activity, the satellite is rotated at 4 rpm and data collected over a number of minutes to produce a data set of sufficient size. The CubeSat Simulator is programmed to send data points every second. To simulate reducing the collection rate, data points are simply thrown out and the remaining data is graphed to see if there remains an accurate representation of the full data set. The Nyquist rate for a satellite rotating at 4 rpm would dictate that 8 samples per minute be collected (twice the rotation rate of the satellite) or data points every $60/8 = 7.5$ seconds. In Figure 27, the data rate is reduced in steps by throwing out data points to simulate collection rates of every 1 second (the default raw data rate), 4 seconds, 7.5 seconds, 12 seconds, and 16 seconds. In

comparing the resulting graphs, the reduced rate down to 4 seconds still produces a fair representation of the sine wave, but at the slower rate of 7.5 seconds (just below the Nyquist rate) the graph begins to show signs of distortion, and at the rates of 12 and 16 seconds, the graphs show a sine wave that is totally different than what is actually happening. This illustrates the concept of aliasing that results from an insufficient sampling rate (a common problem that must be dealt with in DSP).

This activity illustrates that care must be taken when interpreting telemetry data. So for the CubeSat Simulator rotating at 4 rpm, the data rate can be reduced to around 6 seconds between points to conserve power without reducing the information that can be gleaned from the data, however rates lower than that, while further more conserving power, will corrupt the data. This situation would be evident if the students collect the data using the Morse code telemetry mode which is sending data at a rate far below the minimum Nyquist rate.

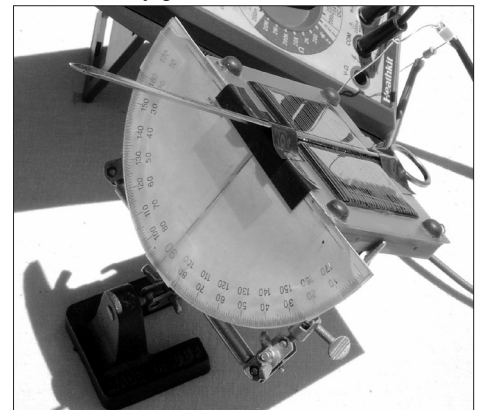


Figure 20: Current measurement angle adjustment setup.

Conclusion Part 2

I envision that the CubeSat Simulator will prove to be a valuable resource that teachers (and hams) can use to help their students to better understand the fundamentals of satellite operations so the students can better appreciate satellite technology that our society is becoming ever-increasingly dependent upon, and want to learn more about space borne assets at an advanced level. Perhaps the CubeSat Simulator will stimulate your fellow ham radio operators to want to "see you on the birds." For additional information about the CubeSat Simulator, or any of the other ETP projects and resources, contact Mark Spencer, WA8SME, at mspencer@arrl.org or 530-495-9150 (Pacific Time Zone). ☺

Figures continue on the next 3 pages ...



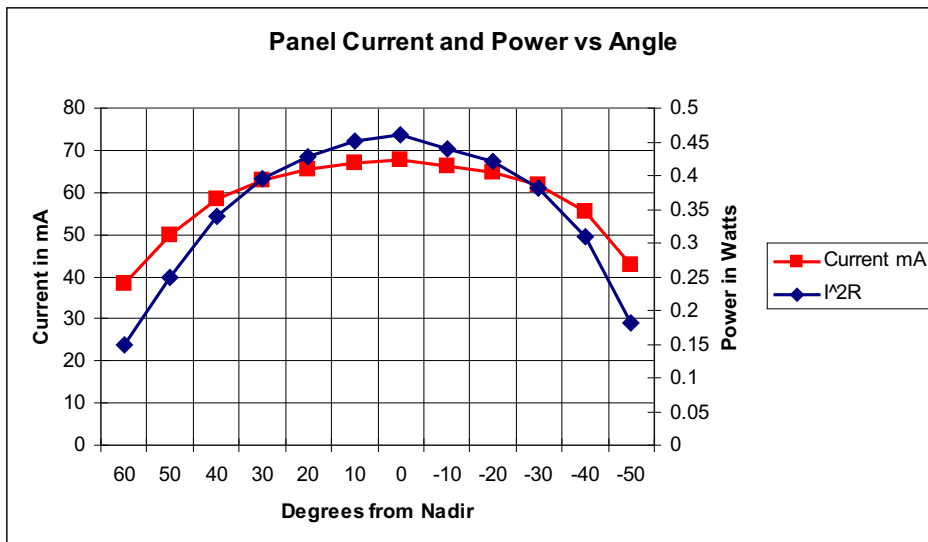
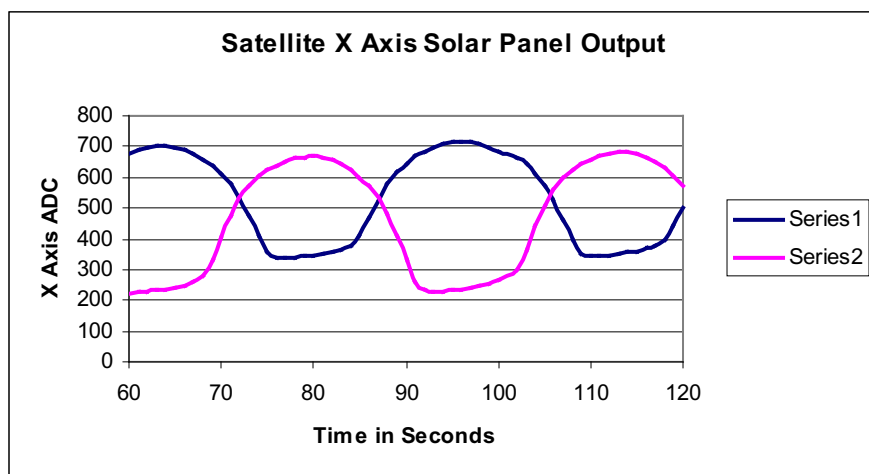
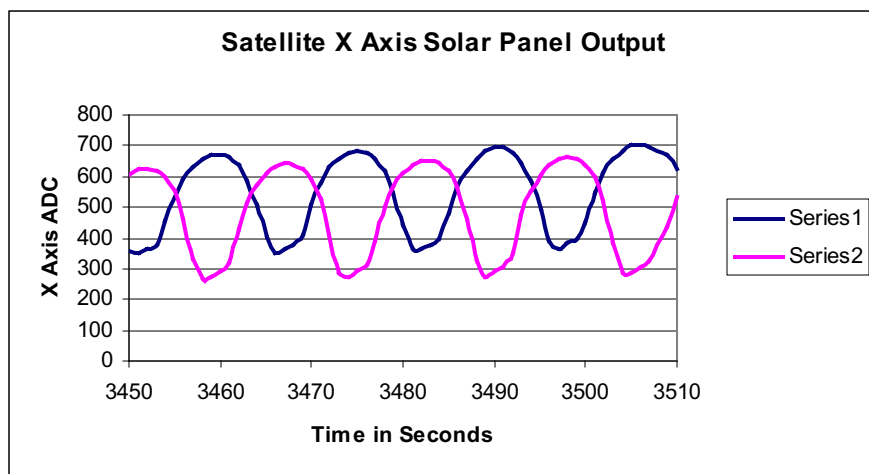


Figure 21: Excel generated graph of angle vs. current.



Figures 22-1 and 22-2: Excel generated graphs of rotation rates of 4 and 2 rpm. Measuring periods gives insight into rotation rate.

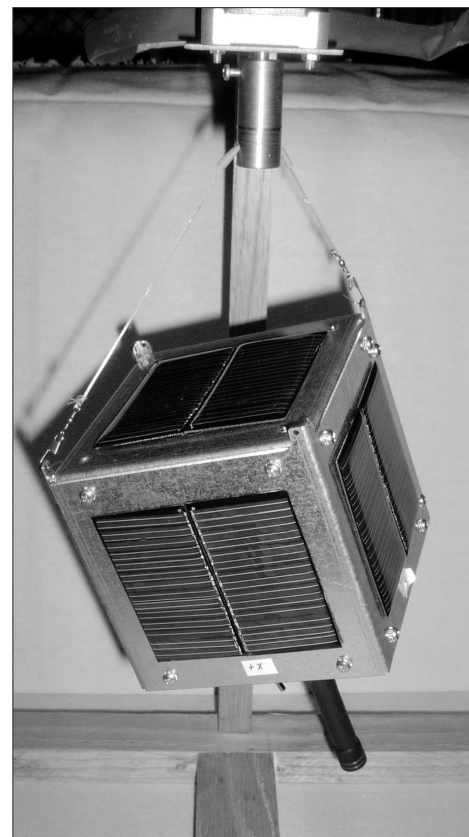
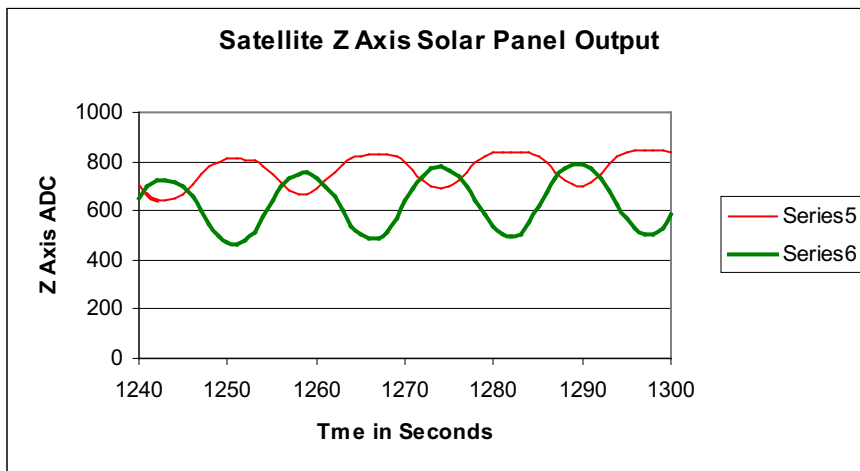
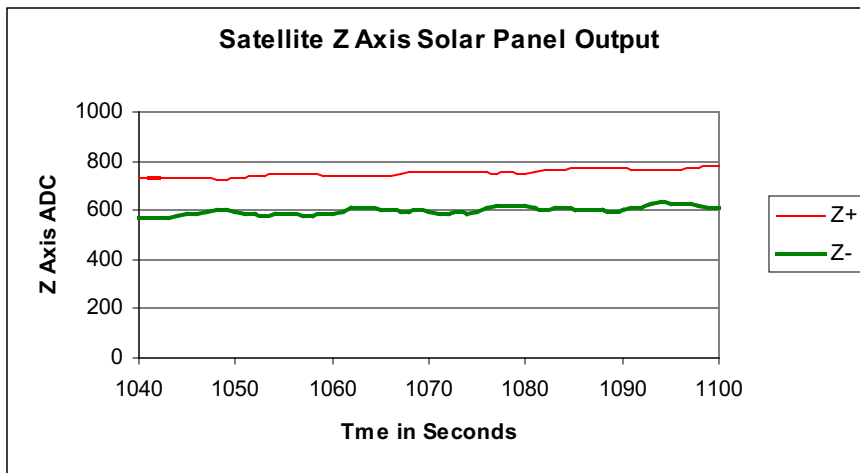


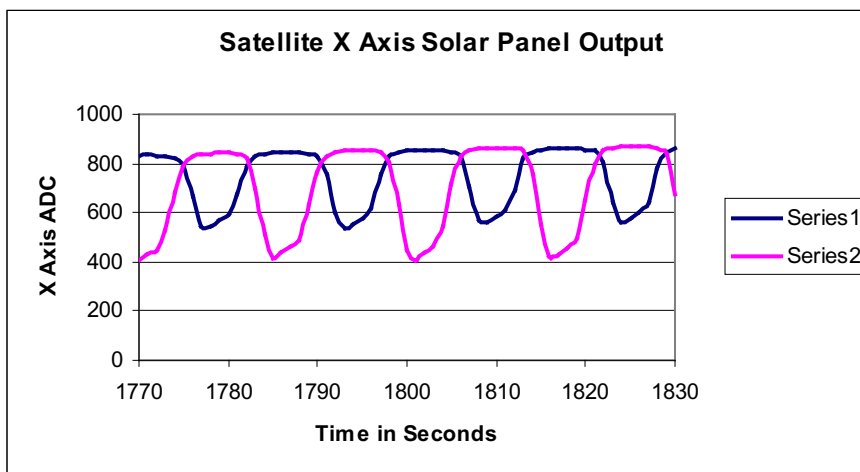
Figure 23: Tilt the satellite at various angles from nadir.



Figure 25: Degrade panel by covering it with an opaque paper.



Figures 24-1 and 24-2: Excel generated graphs of data from nadir to some off-axis tilt. The Z-axis panels pick up sinusoidal characteristics.



Figures 26-1 (above) and 26-2 (next page): The problem with one of the panels is evident by comparing data plots.

on spacecraft experience for engineering students.

Moving forward AMSAT continues to deal with ITAR. Our four commodity jurisdiction requests that were submitted to the State Department last July to transfer export control of those subsystems that AMSAT was developing for Phase 3-E (and eventual placement into Eagle) to the Commerce Department were denied. Again, AMSAT is left with no clear guidance on what constitutes appropriate behavior regarding development of spacecraft systems in an open source public domain environment that AMSAT has always followed. Consequently, we submitted an Advisory Opinion request to the Directorate of Defense Trade Controls (DDTC) on December 4th asking specific questions regarding AMSAT's activities and whether the steps we are taking in public domain will allow us to openly exchange technical information with AMSAT-DL and AMSAT-UK. Without such guidance, AMSAT is left with very restrictive options for working on international satellite projects with other AMSAT organizations.

AMSAT has spent a significant amount of money on legal fees on both ITAR and the clean room litigation. While it has been very disappointing that we're spending money on attorneys and the regulatory process rather than building hardware, this is money that has been well spent given the environment in which we've found ourselves. We at least have resolved the legal issues regarding past ITAR activities with P3-E and freed ourselves from a disappointing relationship with UMES/HISS. Again, we're now in position to move forward rather than continue to deal with past concerns.

Moving forward ... NASA has informed AMSAT that the schedule of work for EVAs at the International Space Station is being revised. The planned deployment of ARISSat-1 from the ISS is now being scheduled for either Fall 2010 or early 2011 rather than Spring 2010. This schedule adjustment also impacts when ARISSat-1 will be flown to the Space Station with upload likely to take place sometime in summer 2010 rather than in January. These revisions were made in response to new higher priority ISS work that must be done during the EVA that ARISSat-1 was originally scheduled to deploy in April 2010.

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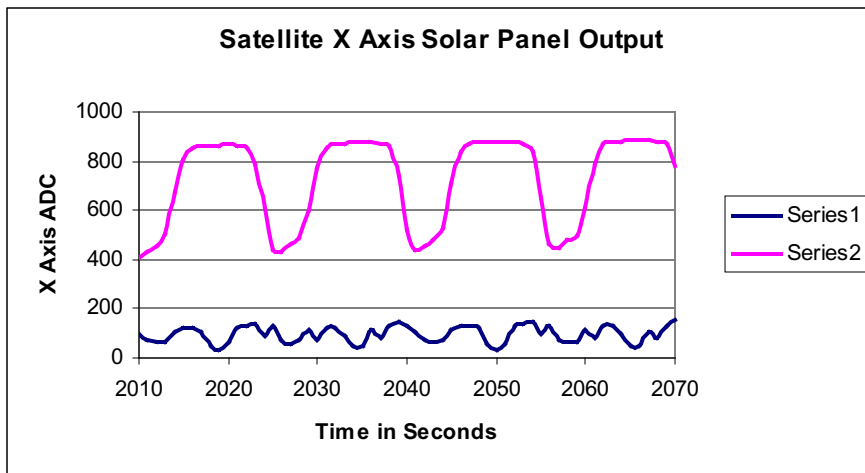


Figure 26-2 (above): The problem with one of the panels is evident by comparing data plots.

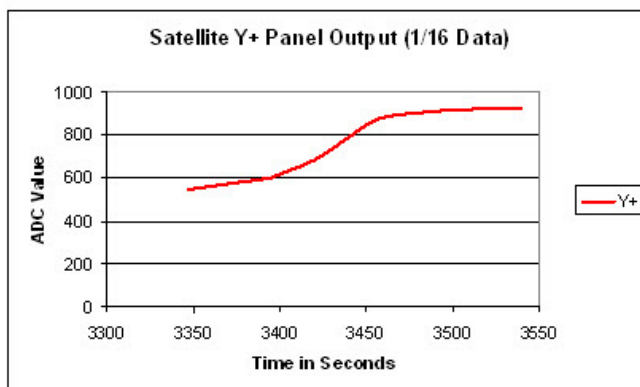
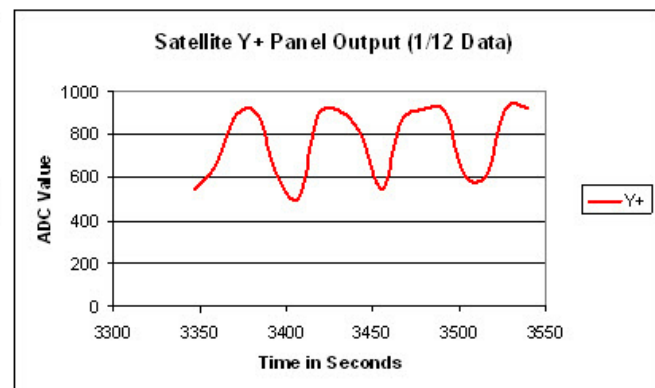
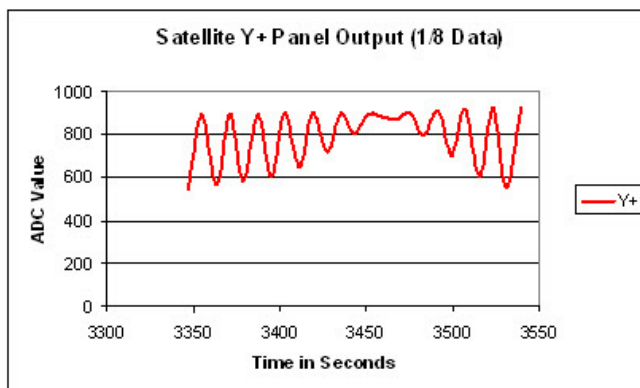
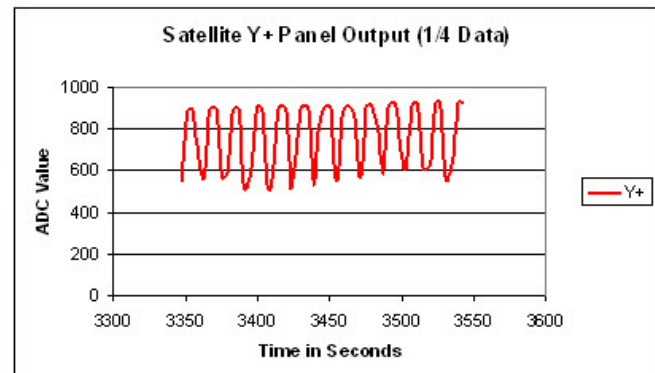
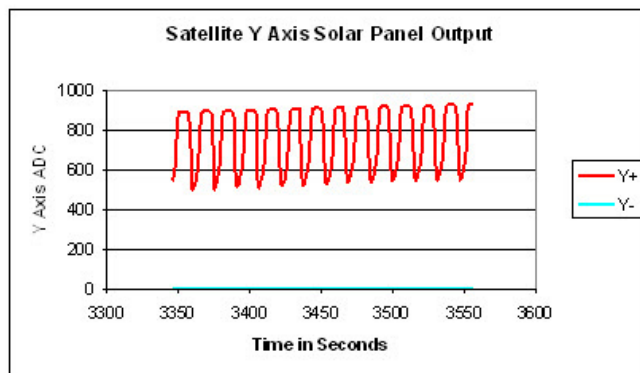


Figure 27: Simulate data collection rate reductions by “throwing out” data points. At rates just above the Nyquist rate, the data looks right; at or below the Nyquist rate, the data is aliased. Reducing the data collection rate below the Nyquist rate results in aliasing.

Diplexer for the Satellite User

by Ron Cade, W6ZQ, ron.w6zq@gmail.com

Over the past 5 years I've been working to improve the receiving and transmitting performance of my ICOM W32/Arrow antenna combo. I've actually had these two pieces of equipment for about nine years but didn't think much about how efficiently they worked with the Comet 4160 diplexer that I was using at the time.

Actually the thing that troubled me the most was the weight, a heavy diplexer and 3 additional adaptors to make all of the BNC connections. My first impression was to remove the circuit board from the Comet enclosure and make direct coax connections to the antenna and radio, which eliminates most of the weight and place it in a miniature plastic box.

During the board extraction period I noted how wide the band pass was on the low pass and high pass filters. The low pass filter bandwidth was 1.3 to 170 MHz and high pass filter bandwidth was 350 to 540 MHz. This is an area that can be improved upon to make it more efficient in the narrower satellite frequencies that I use. Now that the board is out, it's time to make some modification, but first we need to look at ELSIE for direction.

ELSIE is a software program that is on a disk that comes with *The ARRL Handbook*. I won't go into the program's full capabilities. However it will perform the mathematics to determine component values for a multitude of filter configurations and provide performance charts. This is the tool that I use for designing the diplexers that will be discussed in this article.

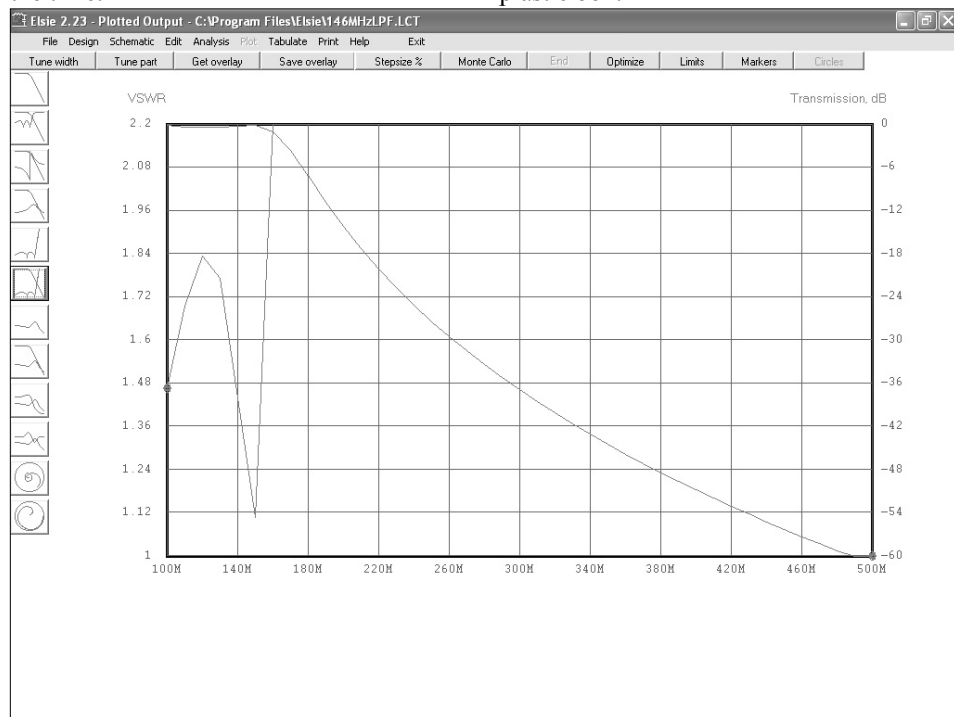
After opening ELSIE version 2.23, select New Design. I split up the diplexer into a inductor input low pass filter and a capacitor input high pass filter using the Butterworth family. The 3 dB bandwidth was set at 170 MHz for the low pass filter side and 280 MHz for the high pass filter. Order number is 5 and input termination 50. After inputting these parameters, details of each filter can be reviewed independently by selecting Schematic, Analysis, Plot and Tabulate on the tool bar. Adjustments to the design can be made by clicking Edit on the tool bar and changing component values as needed. Try to settle on even number values and review again using functions on the tool bar.

Another feature of the ELSIE program is a coil winding routine. Select Wind L on the tool bar and enter the inductance value or select from the "use list at left" button.

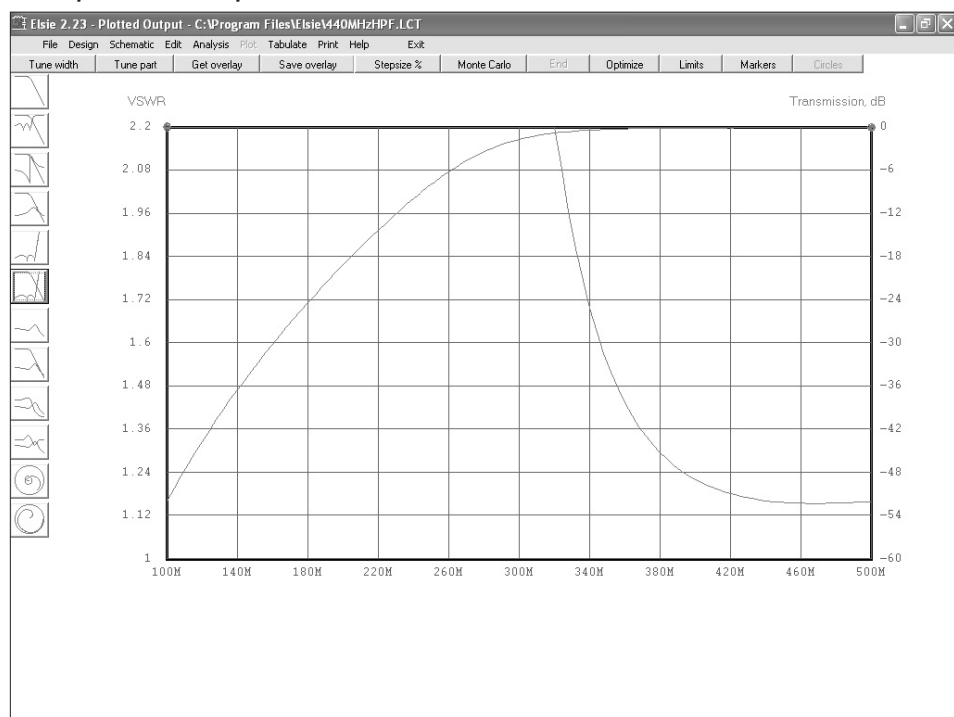
Design goals for this project are:

1. 3 dB cut off frequency at 170 MHz on the low pass side
2. 3 dB cut off frequency at 280 MHz on the high pass side
3. low insertion resistance
4. adjustable capacitors for fine tuning
5. light weight packaging

With these goals in mind I proceeded to make some changes to the Comet board and also build up a prototype on a scrap piece of copperclad board machined out with a Dremel tool. Both of the circuits worked



ELSIE plot for the low pass filter.



ELSIE plot for the high pass filter.

equally well, however I liked my proto unit better because the board was smaller and fit into a small plastic box that I had on hand.

The modifications made to the Comet board were replacing the fixed capacitors with Sprague Goodman ceramic dielectric trimmer capacitors and replacing the 4 turn coil with a 5 turn coil. Each filter was adjusted for minimum attenuation on the low pass side at 146 MHz and 436 MHz on the high pass side.

This past summer I happened to mention to Mark Spencer, WA8SME, that I had been working on a diplexer more in tune with the frequencies that we use for AO-27 and AO-51.

Mark took my ELSIE generated design and within weeks had built up and tested a prototype which proved to be close to the desired design goals. Insertion losses indicate a 1.29 dB loss on 2 meters and a .79 dB loss on 70 cm. The strong point of the design however is the variable caps and the ability to tune the diplexer for a specific duty such as the satellites as opposed to the one size fits all approach using fixed caps.

With a comfortable design in hand, a set of professionally manufactured boards were ordered, coils were wound out in my garage shop and variable caps ordered from Mouser. Within two weeks two fully tested and functional units had been completed.

These diplexers have since been tested on the air and perform as well as the first homebrew model that I have been taking with me on my trips to Hawaii.

Below is a list of recommended parts if you wish to build one for yourself.

Yellow cap, 7-40 pf, Mouser p/n 659-GKG40015

Red cap, 5-20 pf, Mouser p/n 659-GKG20015

2 turn coil, #18 wire, 6 mm ID

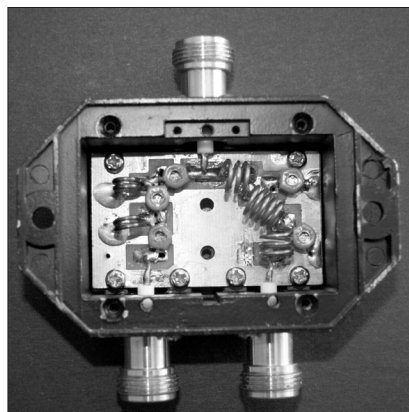
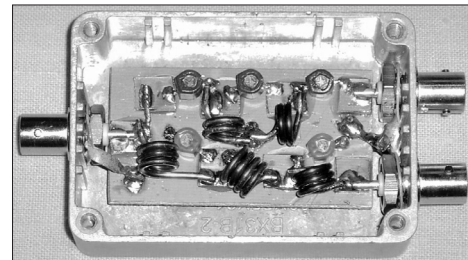
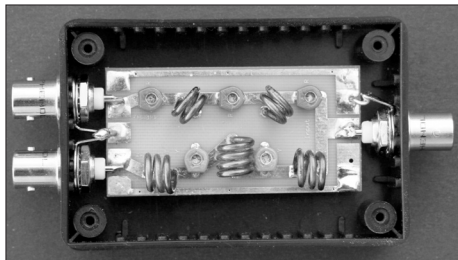
3 turn coil, #18 wire, 6 mm ID

4 turn coil, #18 wire, 6 mm ID

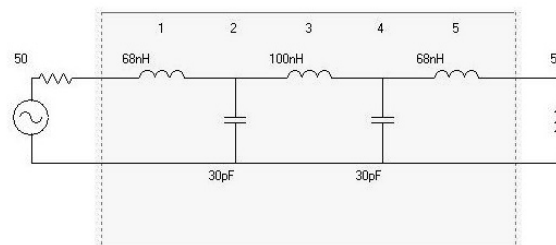
BNC connector, Mouser p/n 523-31-320-RFX

Hammond plastic box, Mouser p/n 546-1591MSBK

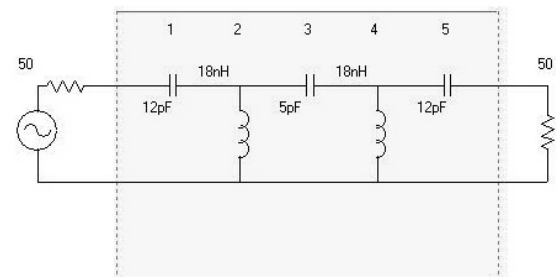
The printed circuit board is available from W6ZQ. E-mail to: ron.w6zq@gmail.com



Three different implementations of the diplexer design.



Low pass filter schematic.



High pass filter schematic.



W6ZQ/KH6
South Point, Hawaii
BK28

W6ZQ/KH6 enjoying his diplexer while working the satellites.



The FM Satellites - A Considerate Operating Practice

by Ib Christoffersen, OZ1MY

The first version of this article was published in 2000, but with some modification it is still useful. I wrote this because the operating practice on the FM satellites by a few operators is less than productive. Unfortunately it makes it difficult to have real QSOs for the rest of us.

The FM satellites function just like an FM repeater. They can accommodate only one station at the time. This makes it necessary for us to be very considerate when we use these satellites. We have a number of satellites using frequency modulation operating at the moment. That is a good thing since they obviously attract a lot of new operators to the Amateur Satellite Service.

We have AO-51 and SO-50 both on all the time and AO-27 on for 6 to 7 minutes during daytime south to north passes.

The operating practices of a large number of us in Europe are appalling. People call on top of one another, whistling, using repeater tones, do not allow a QSO to finish, call OHLA-OHLA, call CQ three to four times and include the locator and so on. Some seem to have the idea that it is their satellite and they therefore monopolize whole passes using excessive power to "drown out" low power stations.

The most popular satellite, AO-51, attracts quite a large crowd on every pass. If you want to hear examples of the above, try to listen to this very useful satellite during a weekend pass on 435.300 MHz plus/minus Doppler.

I do not pretend to have the perfect solution to these problems and I most certainly do not want to be called a policeman on the satellites, but a gentleman's agreement would make life (an overstatement - it is just a hobby) a lot easier for all of us.

The golden rule - do not transmit if you cannot hear the downlink, is not known by some stations. I have personally called a lot of stations, where my downlink signal has been very good, but the station called did not answer or asked for the call again several times and then gave a 59 report.

In my humble opinion we should adhere to some simple rules, which I will put forward here:

Calling "CQ Satellite" 3, 4 or more times and giving your call and the full locator at

the same time is non-productive. It simply takes too long. Experienced operators easily pick out new stations using a short CQ call. It is not really necessary to call CQ - just give your call.

Considerate operating practice allows a QSO to finish. Many operators on the FM satellites do not adhere to this. You very often find a station calling on top of a running QSO, which makes the QSO take much longer time than necessary. Often it is because the QSO takes a long time, which leads to the next "rule".

Make the QSO short when the satellite is busy. Valid QSO's just need to exchange calls and signal report. That is it. You do not need locator or operator name. If there is very little traffic, OK go ahead and talk about anything, but not when the satellite is busy.

Here in Europe we also have the habit of asking for the full locator. I have tried to avoid that, but I have failed in this respect. For a terrestrial QSO or in a contest you need the full locator, but not for a satellite QSO.

A considerate operator will make one QSO per pass. If you are an experienced operator, who has made a lot of contacts before, limit your contacts to new stations.

Do not use the FM satellites to elaborate on the weather situation in your local area when the satellite is busy.

Give priority to portable and mobile stations if they can hear the satellite.

Give DX stations (rare calls) a chance to get through. I have witnessed JW stations being "drowned out" by local QSO's.

If someone is really annoying don't try to block their signal. Instead try to send them a polite e-mail, especially if they are from your own country.

Also respect people if they want to use their own native language. It is perfectly OK to speak in Danish, German, Russian or any other language, as long as they do not carry on for many minutes.

Do not talk very fast. It will not help. Remember we have different languages and use phonetics.

Look at your satellite-tracking program to avoid calling stations that are out of the footprint.

If you are a newcomer to satellites try to use

them on a weekday morning.

QRM from non-radio amateurs and non-satellite radio amateurs

Over the years I have heard taxi drivers in Spain, music from Arabic countries, telephone conversations in Russian - Danish, Dutch, German, Italian, Spanish (the list could continue) radio amateurs using the uplink frequencies for local calls, packet transmissions from Siberia - all over the FM satellites.

Some of these problems with other radio amateurs can be solved if you have the calls. Just send the radio amateur an e-mail and ask them politely to stop the transmission. I have had good experiences with radio amateurs in Denmark and other countries in Europe.

Approaching your local authorities can perhaps solve a number of these problems with misuse of the frequencies. When the offender is in a foreign country it is the only way to deal with this. Use your national radio amateur organization. That is one of the reasons for their existence.

Final Remarks

The FM satellites are a great asset to our hobby since they attract a lot of new operators. A large number of these new operators move to the other satellites and become potential supporters of AMSAT.

Despite the above, the FM satellites are fun, but do not try to work through them on a day where you are in a bad mood.

The schedule for AO-51 is on: <http://www.amsat.org/amsat-new/echo/CTNews.php>

Ib, OZ1MY, is a member of the AO-51 Operations Group. ☺



ARISS/AMSAT at Ottawa Fest

by Maurice-Andre Vigneault, VE3VIG,
AMSAT Canada Delegate to ARISS-International
ARISS-I Educational Outreach/School Selection Committee

Lots of interest was shown for the ARISS/AMSAT display at the OARC Amateur Fest in Carp, just west of Ottawa, on Sept 12, 2009. This time, we had the AMSAT banner up, and the ARISS display with CSA, AMSAT and ARISS handouts, which were picked up quickly by the many visitors to our booth.

Ottawa area. We informed visitors about the state of our fleet of satellites providing activity today and the upcoming program for better satellites in the future, namely modular construction and software defined transceivers.

Part of our display was dedicated to a setup of basic equipment to work the Low Earth

Orbit (LEO) satellites in Ottawa and we tested the HF path to Poldhu while their club was assembling for a reunion. Good signals both ways were reported, but around 3 PM our time, the 20 m band started to fade. Nevertheless, HF would be another way we could coordinate our satellite contacts for their visitors in the earlier part of the day.

Our next outing will be on October 24, at the Montreal Fest, in nearby Longueuil, not far from the Canadian Space Agency. We expect to meet with another interesting group of people and spread the good word on ARISS and AMSAT. ☸



Photo 1: VE3VIG, VE3OIJ and VE3PU at the AMSAT booth. Photo by Bob Baillargeon, VE3MPG

Darin, VE3OIJ, our new team member on the ARISS-International Project Selection and Use Committee was along to help me handle the crowds. In Photo 1 you can see three ARISS-I representatives talking with booth visitors. At the far left, is me, VE3VIG, in the center, behind the AMSAT banner is Darin, VE3OIJ, and seated is Ken Pulfer, VE3PU, who is on the Public Relations Committee.

We responded to many inquiries about the ARISS program which resulted, through e-mails in the following weeks, in several follow-ups from schools regarding the application for an ISS contact.

Visitors also came from outside of the

A special visitor to our display was from the Cornwall UK region. Keith, G0WYS, is the secretary of the Poldhu Amateur Radio Club. (See Photo 3.) Poldhu is the location from which Marconi transmitted his first signal across the Atlantic to Signal Hill, Newfoundland on Dec 12, 1901. Their club is located inside the Marconi Museum and Keith was wondering how to interest the public in the works of Marconi and Franklin, his assistant. I suggested that they set up an ARISS contact right at the museum.

Then, later on, with their satellite equipment, we could make regular contacts via the satellites whose footprint would cover both our areas. That certainly would be an interesting demonstration to compare with the early works of Marconi.

Keith visited our VE3JW exhibit station

in Ottawa and we tested the HF path to Poldhu while their club was assembling for a reunion. Good signals both ways were reported, but around 3 PM our time, the 20 m band started to fade. Nevertheless, HF would be another way we could coordinate our satellite contacts for their visitors in the earlier part of the day.

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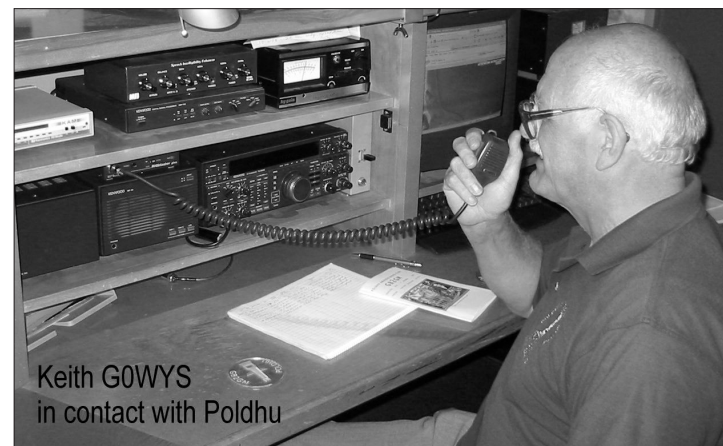


Photo 3: Keith, G0WYS, operates in contact with the Poldhu ARC in England. Photo by Keith Matthew, G0WYS



Photo 2: VE3VIG manning the AMSAT booth. Photo by Larry Wilcox, VE3WEH

The ARISSat-1 Linear U/V Transponder

Bill Ress, N6GHZ, n6ghz@amsat.org

ARRISat-1 Team Member

Introduction

In this *Journal* issue, I'll describe the ARISSat-1 linear communications receiver (COMMRX). The linear communications transmitter (COMMTX) will be described in the next issue.

ARRISat-1 will be flying a linear transponder having an uplink at 435.750 MHz (COMMRX) and a downlink at 145.938 MHz (COMMTX). The uplink passband will be 16 kHz wide and will support one FM channel and up to four SSB signals. The downlink signal will be 40 kHz wide and will not only include the 16 kHz linear segment, but an FM signal used for SSTV and voice announcements, a BPSK telemetry channel and the CW beacon signal, all generated in the SDX. The downlink transmitter will provide 0.5 watts RF output shared between the four information channels.

Overall Design Objectives

As with any satellite application, efficient use of the available power is the essential first consideration when designing satellite systems. DC to RF conversion efficiency must be the highest possible in both the COMMRX and the COMMTX. Size and weight are the next important design considerations.

An added design consideration for ARISSat-1 was that all the system functions were to be designed with "modularity" considerations. At the October 2008 AMSAT-NA board meeting, it was decided to develop all new systems so that they could be configured to build a satellite which would meet "any" launch opportunity. This meant designing for a satellite as small as a CubeSat.

COMM RX Block Diagram

The 435 MHz COMMRX block diagram, as shown in the Figure 1, is a linear, low noise, single conversion down converter with an IF output at 10.7 MHz. The 10.7 MHz output has an adjustable output level of -15 to 0 dBm, but is nominally set to -10 dBm. This 10.7 MHz signal feeds the SDX. The down converter also incorporates AGC which keeps the 10.7 MHz IF output constant with RF input levels of -120 dBm and higher. The noise figure is nominally 3.5 dB.

The high side local oscillator at 446.442 MHz is provided by a phase locked loop (PLL) oscillator, a Si5338 by Silicon Labs, with its reference being a 19.2 MHz temperature compensated oscillator. It provides +/-2.5 PPM frequency stability over -30 to +70 degrees C.

The COMMRX shares its input filtering at 435 MHz and its low noise amplifier (LNA) with the command receiver (CMDRX). The 435 MHz signal is split after the first LNA in a lumped 435 MHz power divider and cabled to the CMDRX which sits "piggy back" on top of the COMMRX, sharing its same hole mounting pattern.

During the design process, two tone intermodulation testing was done to maximize amplifier stage efficiencies while maintaining adequate "headroom" to insure linear operation. This design tradeoff resulted in a COMMRX module which requires 135 mA at 8 Vdc, or 1.08 watts. The power system supplies 8 VDC and is down regulated in a linear voltage regulator (linear because it is low noise) to 5 VDC. If the COMMRX was run from a 5 VDC

supply, the input power would then only be 675 mW. It should also be noted that all the active components in the receiver can run from 3 to 3.3 volts. Running the receiver from 3 volts (such as directly from 3 volt solar cells) would lower the input DC power to 390 mW.

RF and IF Filtering

Instead of using the helical filters for the 435 MHz input, very small SAW filters are used. Two of these filters are used prior to the active mixer and they provide over 90 dB of image rejection. The 10.7 MHz filters are small ceramic filters, each having a 1 dB bandwidth of 50 kHz. Using these small filters significantly reduces the size and height of the PCB assembly.

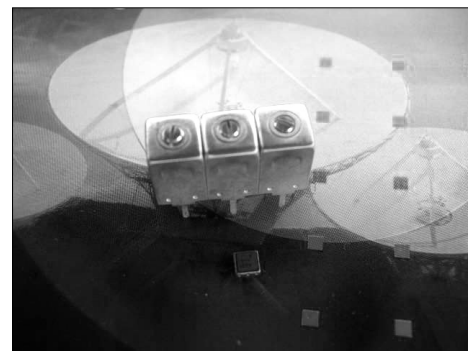


Figure 2: SAW filters.

Size

The size of the PCB is the same as the COMMTX, which is 60 cm (2.35") by 71 cm (2.8"). The height of the COMMRX assembly is just 6.9 cm (0.27"). It uses the same mounting hole pattern as the COMMTX permitting the two to be stacked. When stacked using a metal shielding plate between them, their combined overall height can be less than 19 cm (0.75").

Schematics

Two engineering prototypes have been built and these have been used for various demonstrations and system testing. The current schematics are located on the ARISSat-1 documentation Web site at <https://svn.sarpeidon.net/viewvc/suitsat2/RF%20System/>. But it should be noted that as we finish building the flight units, the TBD (to be determined) and SAT (select at test) component values are being defined. As the flight configuration becomes fixed, the schematics will be updated and posted on the ARISSat-1 documentation Web site.

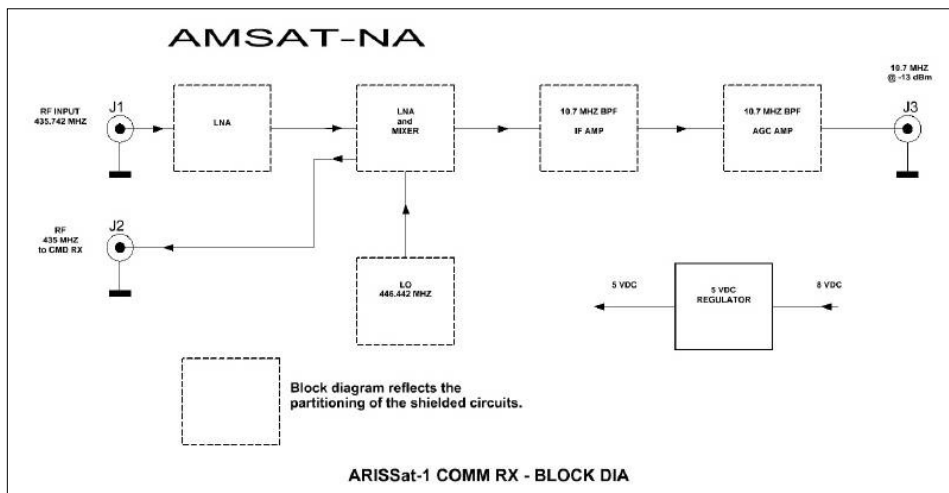


Figure 1: COMM RX block diagram.



The 435 MHz COMMRX Performance Data Summary	
RF Input:	435 MHz
Noise Figure:	3.5 dB
Image Rejection:	> 90 dB
AGC Threshold:	-120 dBm
IF Output:	10.7 MHz
IF Output Level:	-15 to 0 dBm
DC Input:	8Vdc @ 135 mA
Size:	60 cm (2.35") by 71 cm (2.8") by 6.9 cm (0.27") high

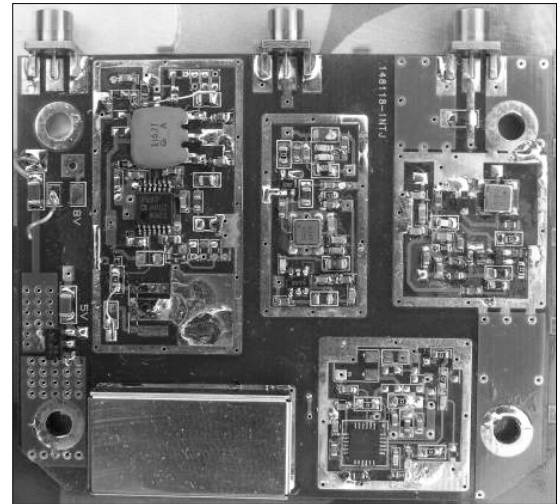


Figure 5: Assembled COMMRX printed circuit board.

PCB Layout

When looking at the PCB layout, you'll notice rectangular and square circuit areas. This is designed to permit the soldering of rectangular and square metal shields to isolate and shield the circuit functions from one another and any undesired external signal influences.

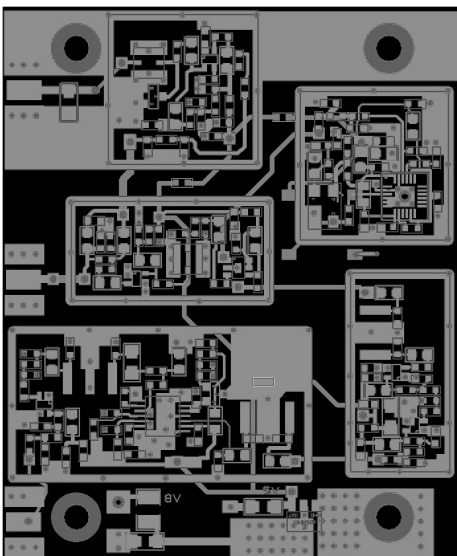


Figure 3: COMMRX PCB layout.

Housing

The COMMRX in the housing is shown in Figure 4. Not shown is the CMDRX which sits on top of the COMMRX using standoffs. You'll note that the enclosure has a lot of extra room which was designed to accommodate an earlier design, which was not tasked with being small enough to fit into a CubeSat. The COMMTX sits below the COMMRX in its own compartment. Figure 5 shows the assembled PCB for one of the engineering prototypes. 🌐

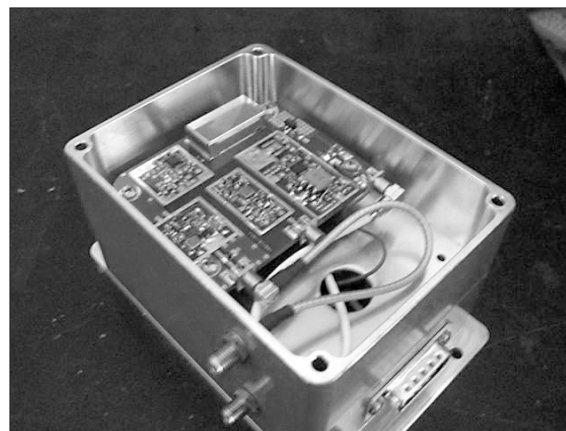


Figure 4: COMMRX in the housing.

STS-129 CEIT

by Lou McFadin, W5DID, w5did@amsat.org

September 11, 2009

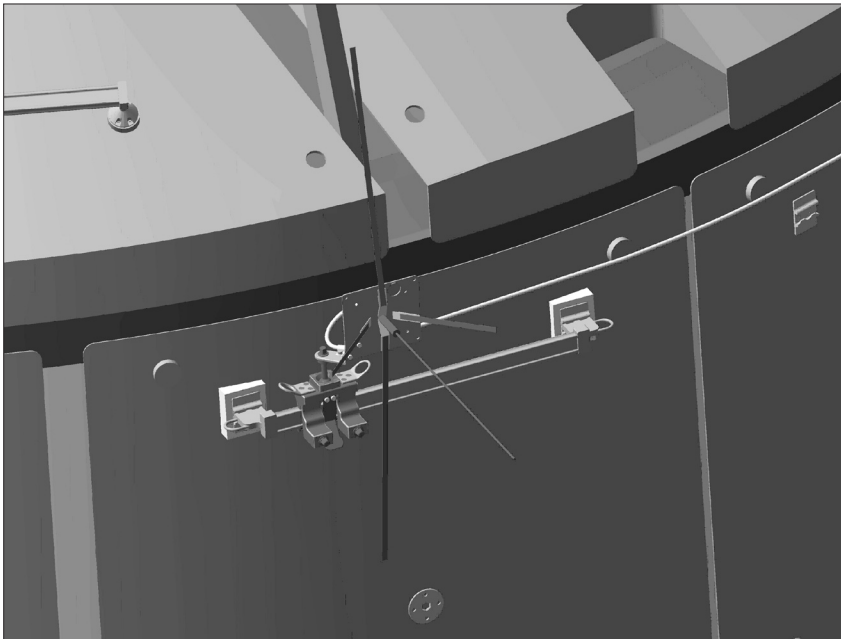
On this date many NASA engineers and the STS-129 crew gathered at the Kennedy Space Center to conduct the traditional Crew Equipment Interface Test (CEIT) for STS-129. The purpose of this "test" is for the upcoming Shuttle crew to get a final look at the equipment that is being taken onboard for their mission. The crew actually examines every locker to look at the tools and experiments and special items that may be needed in an emergency. On this day exactly eight years after the infamous 9/11 attack, everything was fairly routine except

have been in use for several years and are performing flawlessly.

The call was made to the ARISS U.S. hardware manager Lou McFadin, W5DID, who built the antennas for the Service Module. ARISS and AMSAT accepted the challenge. The path to orbit on ISS is a long and difficult one, but the flight antennas were designed built and shipped to the ESA facility ESTEC in Noordwijk, the Netherlands, in early 2009. After much testing and integrating the antenna to the ESA clamp and cable, all was shipped to JSC. At JSC they prepared the boxes

and the cushions where the antennas will be stowed on the Shuttle. They will be in the cargo payload bay for the ride to ISS in a box called the TSA (Tool Storage Assembly). The crew will remove the AIS and ARISS antennas and cable from this box during the second EVA of the STS-129 flight.

This new antenna will pave the way for adding VHF and UHF capability to the Columbus Module. This will enable more casual contacts from ISS and hopefully more school contacts. We are all looking forward to this new capability in the Columbus Module on ISS. 🌐



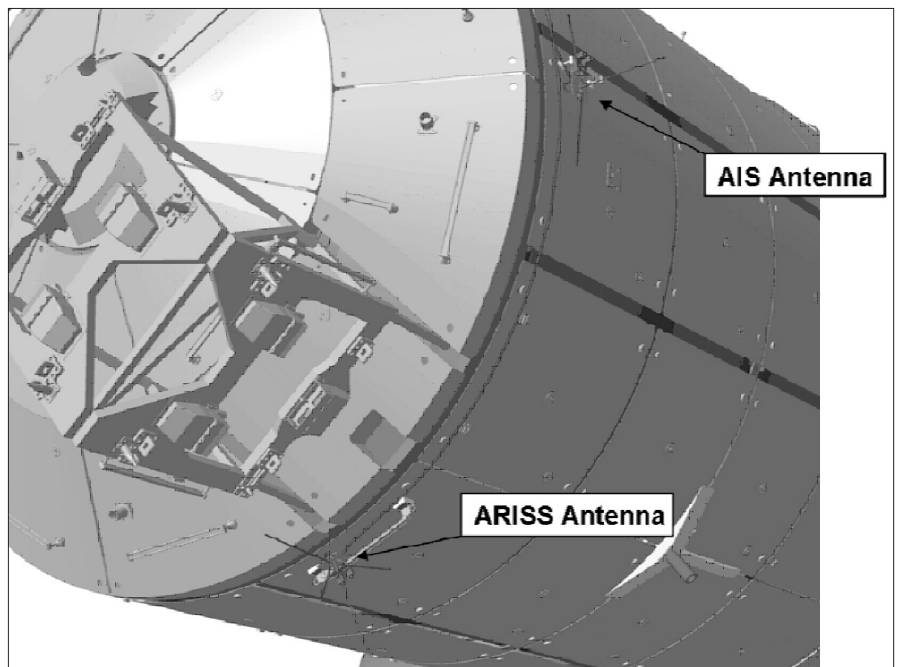
How the antenna will be mounted.

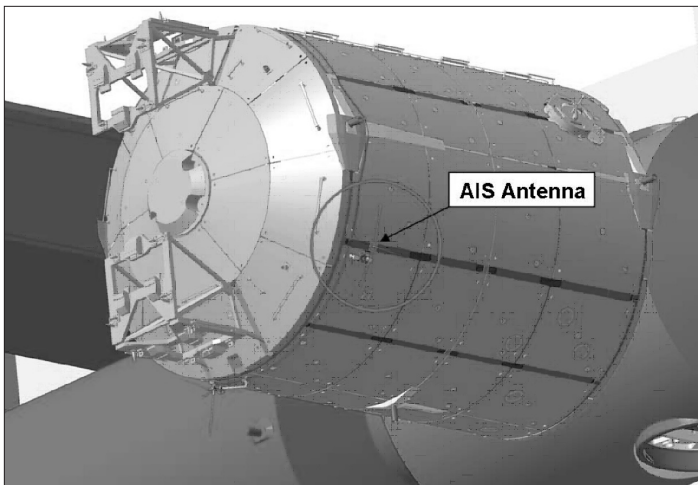
this time AMSAT had a presence.

On STS-129 they will also carry an antenna for AMSAT and ARISS designed to be installed on the outside of the Columbus Module. We can credit Mark Severance, N5XWF, for this unique opportunity. Mark works for NASA at JSC and is an avid supporter of AMSAT and ARISS. At the time this opportunity presented itself, the AIS (Automatic Identification System) team was in the process of preparing an experimental receiver and data analysis system to be flown on ISS in the ESA Columbus module. The team was having some trouble getting safety approval of the antenna for AIS. Mark suggested that the ARISS team had been quite successful with a similar antenna on the Russian Service Module. These antennas

Photos continue next page....

Antenna locations on the Columbus module.





Antenna locations on the Columbus module.



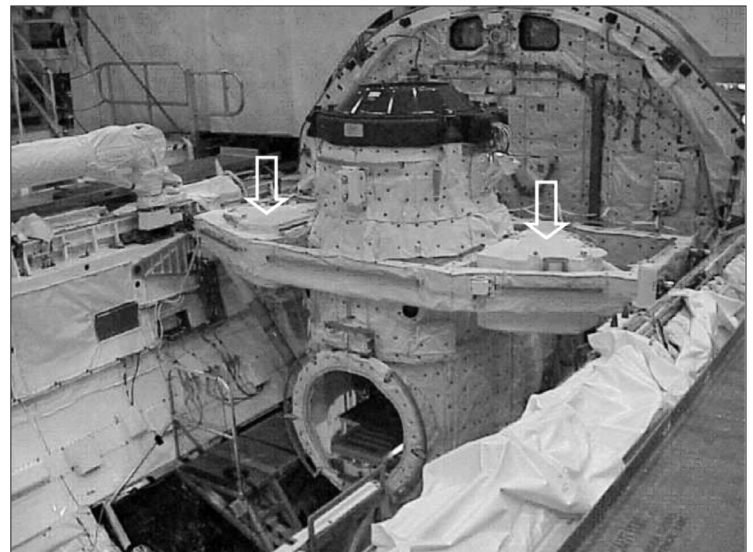
AIS antenna (stowed) configuration.



ARISS antenna (stowed) configuration.



MS2 Randolph Bresnik (left - partially out of the picture) inspecting the ARISS antenna.



LWTSA containers installed in the OPF.



The AIS and ARISS antennas stowed in the TSA (Tool Storage Assembly).



The AIS-ARISS team L-R: Lou McFadin, W5DID (AMSAT), Astronaut Randy Bresnik (NASA), Hans-Joerg Beestermöeller (Astrium), Elke Siedenhans (Astrium), Stefan Wuebker (Astrium), Jeff Wirth (Boeing) cushion designer, Horst Koenig lead engineer (ESA/ESTEC).

Minutes of the AMSAT BoD Teleconference September 1, 2009

Called to order by Barry Baines at
2005 EDT

Attending:

Directors:

Gunther Meisse
Gould Smith
Barry Baines
Drew Glasbrenner
Lou McFadin

Others:

Lee McLamb, Secretary
Alan Biddle,
Bill Ress,
Martha Saragovitz, Manager
Frank Bauer

AMSAT President Barry Baines provided an initial overview of an educational opportunity between AMSAT and University of Binghamton.

Gould Smith and others emphasized the need to identify the volunteers up front as well as identifying how much time and other expectations would be involved.

Frank Bauer raised the issue that we need to ensure our agreement adequately addresses ITAR concerns.

It was recommended that Dr. Fitz-Coy of UF be advised of this activity and also extend the offer of a paid Symposium registration.

Barry Baines made the motion:

“AMSAT commits to the support of the University of Binghamton NextGen CubeSat proposal and agrees to provide \$1,200.00 in immediate funding to the Binghamton Foundation to support student expenses and initially budgets \$10,000.00 to cover material costs associated with hardware development between September 2009 and May 2010.”

Seconded by Gould Smith

Discussion:

Drew Glasbrenner recommended that the board review the project at the end of the first semester before committing funds for hardware development.

Lou McFadin called the question.

Vote: All directors present voted in favor of motion, motion passed as presented.

Official board meeting closed at 20:50 Eastern.

Submitted by,

Alan Biddle, WA4SCA

2009-2010 AMSAT Secretary

Support AMSAT

New Version!

AMSAT is the North American distributor of **SatPC32**, a tracking program designed for ham satellite applications. For Windows 95, 98, NT, ME, 2000, XP, Vista, Windows 7.

Version 12.8a is compatible with Windows 7 and features enhanced support for tuning multiple radios.

Version 12.8a features:

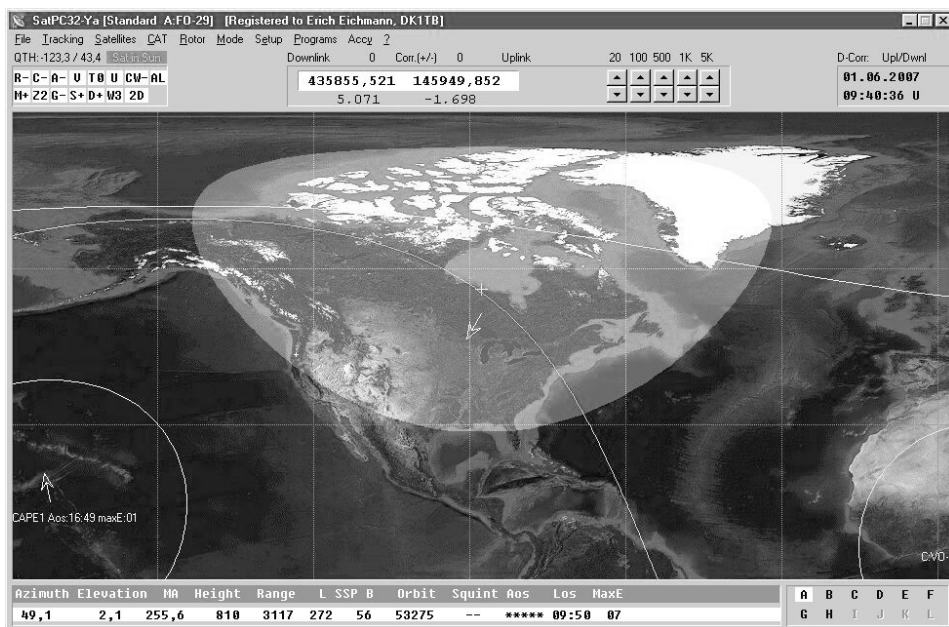
- Select 2D/3D map with a single mouse click
- Select Political/Physical map with a single mouse click
- AOS voice announcement
- Countdown program displays next AOS of your favorite satellites
- Automatic Internet download of Keplerian elements.
- Graphical tracking on a world map with two selectable Zoom factors.
- One-click satellite switching using 12 “letter” buttons.
- Automatic rotor control support for: LVBTracker, Kansas City Tracker/Tuner, FODtrack, Uni_Trac, SatEL, Labjack U12/U3/Piggyback, W0LMD Mini/Junior/Senior Trackers, Yaesu GS-232, ARS from EA4TX, EGIS rotors, IF-100, RIF-PC, AMSAT-DL interface, WinRotor32, HalloRotor, and WiSP DDE clients.
- Doppler tuning with on-screen frequency displays. Radio models supported:
 - Yaesu FT-847, FT-736R, FT-817, FT-857, FT-897
 - ICOM IC-820H, IC-821H, IC-910H and other ICOM radios
 - Kenwood TS-790 and TS-2000
 - DDE client programs
- “Transparent” VFO-knob tuning in addition to keyboard and mouse tuning.
- “Virtual” VFO tracking for half-duplex transceivers FT-817, FT-857, FT-897, IC-706 and IC-7000.
- Includes a special version for ISS split-frequency operation.
- Controls subaudible tone on FT-847, FT-736R, FT-817/857/897, TS790A and IC-910H.
- Includes a non-graphical version and programs that output lists to the screen, printer, or a file.
- Interfaces with WiSP, with user-defined satellite switching priority.
- Includes a separate program for tracking the Sun and Moon.

Price is \$45 for AMSAT members, \$50 for non-members, on CD-ROM.

A demo version may be downloaded from <http://www.dk1tb.de/indexeng.htm>

A registration password for the demo version is \$40 (members), \$45 (non-members). Order by calling 1-888-322-6728.

The author DK1TB donated SatPC32 to AMSAT. All proceeds support AMSAT.





LVB Tracker Box

- Reasonably priced and all profits go to AMSAT
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- Open architecture
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- Power supplied via the rotor controller cable
- Bi-directional interface allows the unit to read the rotor position
- LCD position readout
- Front panel manual control
- Self-programmable, allows for easy software upgrades
- Supported by the major tracking programs
- Uses GS-232A or Easycomm I/II protocols

Contact Martha at the AMSAT office 301-589-6062 to order.

The complete units will be built in groups, so get your orders in early.

Units will be shipped as they become available.

- 1) Bare board - \$20 + S&H - no parts kits available
- 2) Populated board, serial interface - \$100 + S&H - no kit with USB unit, rotor cable and LCD available, we do have a parts list with recommended part numbers and sources.
- 3) Custom Ten-Tec Enclosure powder coat, silk-screened, drilled/punched - \$50 + S&H
- 4) Complete unit - board, USB output, rotor cable, LCD, enclosure - \$200 + S&H **our most popular

Documentation for the LVB Tracker can be found at: <http://www.LVBTracker.com>

Boards and complete units may be ordered from the AMSAT office at 301-589-6062 or from martha@amsat.org

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10' 6" boom

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Overall, this revision helps ARISSat-1 because it provides additional time for testing of the spacecraft. Furthermore, it also ensures that the NASA Safety Review process for ARISSat-1 can be concluded prior to shipment of the spacecraft to Russia.

Moving forward AMSAT members should have received a letter from me this month asking for your financial support "Getting AMSAT Back Into Space."

Clearly, what drives AMSAT is designing, building and successfully placing Amateur Radio satellites in orbit. AMSAT's future is dependent upon continuing to support Amateur Radio in space. The new opportunities that we've identified (Project Fox and a potential rideshare) are both affordable and doable. Please support our efforts to keep Amateur Radio in space.

This is the time of year where we count our blessings and look forward to the coming year. AMSAT has much to be thankful for given the significant efforts of our volunteers and the turnaround that has started over the past twelve months. Despite the challenges of the economic downturn, we are moving forward both in terms of satellite projects and expanding our educational outreach. Please help us to keep this momentum building and to make 2010 an even more successful year.

Happy Holidays,

Barry A. Baines, WD4ASW

President-AMSAT 



Please support AMSAT-NA.
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Help Wanted

AMSAT needs qualified volunteers for a number of positions!

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- Specific area Web site information maintenance
- Video recording, digital conversion and editing
- Write technical or instructional material
- Educational activities
- Promoting AMSAT as an Area Coordinator



and any other area you think you think you can make a difference.

We often have people volunteer, but many don't deliver on their promises. So, pick an area that you think needs improvement and explain what you will do to make it better. Then do something to show that you can follow through.

Send your suggestions, actions plans and a description of why you are capable of doing this task to Gould Smith, WA4SXM, wa4sxm@amsat.org

The AMSAT Store (see www.amsat.org) is back online! Here is a new AMSAT product.

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THANK YOU!



AMSAT Student Membership Category Created

by Bill Ress, N6GHZ, AMSAT-NA Board Member

AMSAT-NA board member Lou McFadin, W5DID, proposed that the board consider creating a student membership category in an effort to expand our educational outreach and make it more affordable for students join AMSAT-NA. At the November 3rd, 2009 telecon board meeting, the board unanimously approved the following motion:

“In order to expand its educational outreach efforts, AMSAT-NA establishes a student category of membership. The yearly rate will be half the standard applicable rate, and shall be available to all students in primary and secondary school. Post-secondary school students enrolled in at least half time status shall be eligible for a maximum of 6 post-secondary years in this status. In addition, the student membership application should indicate: 1) school attending, 2) course of study and 3) expected graduation date.”

The student rates are effective immediately and are as follows:

US: \$22.00, Canada/Mexico: \$25.00 and International: \$27.50 ☎

AMSAT China's XW-1 (HO-68) Satellite Testing Proceeding Well

Amateur satellite operators worldwide have reported receiving strong signals on the telemetry beacon of China's XW-1 satellite launched on December 15, 2009.

The satellite is currently being commissioned. All three Amateur Radio modes, which include an V/U FM repeater, V/U linear transponder and V/U AFSK packet, have been tested.

Michal Chen, BD5RV/4, reported, “I managed to operate the special event station BT3WX to work several E2, BY, VR2, XX9 stations throughout an evening pass of XW-1 using the FM transponder. It was the first open test of this bird's transponder. Everything works just great!”

AFSK packets were active over Japan with JA0CAW receiving the downlink on 435.675 MHz AFSK 1200bps.

JE1CVL, JH1EKH, BD4SY, JF2CTY,

JH1BCL, JA5BLZ succeeded in a QSO over Japan using the linear transponder in VHF (LSB) up and UHF (USB). The linear transponder in inverting on 145.950 MHz (up) and 435.740 MHz (down).

The XW-1 communications payload includes a beacon and three cross band transponders operating in FM, linear and digital modes.

Up: 145.8250 MHz FM, PL 67.0 Hz.
145.9250-145.9750 MHz SSB/CW
145.8250 MHz AFSK 1200 BPS

Down: 435.6750 MHz FM
435.7650-435.7150 MHz SSB/CW
435.6750 MHz AFSK 1200 BPS

Beacon: 435.7900 MHz CW

Users have posted videos on YouTube regarding XW-1:

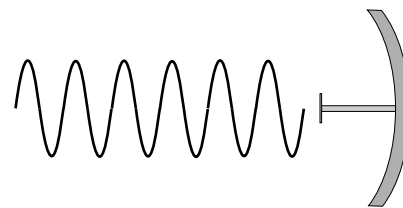
<http://www.youtube.com/watch?v=n40yuC4Sx4&feature=related>

<http://www.youtube.com/watch?v=WwyTZT6JkC4>

Luciano Fabricio, PY5LF, has made a YouTube video showing his reception of the beacon: <http://tinyurl.com/yjgett6>

XW-1 was a secondary payload aboard the CZ-4C rocket from Taiyuan Satellite Launch Center into a sun-synchronous orbit about 1200 kilometers high. The primary payload of this launch is the Yaogen-8 Remote Sensing Satellite.

BD5RV/4 requests Amateur Radio operators send him audio recordings, notes on received content, your QTH, callsign, date/time of the XW-1



beacon you heard to AMSAT China by email. Later, you'll be able to upload it via Web, but for now, email works. Send your files and information to michael.bd5rv@gmail.com.

XW-1 CW telemetry decoder by Mike Rupprecht, DK3WN, can be downloaded from his Web site at: <http://www.dk3wn.info/software.shtml>

You can get an updated copy of the XW-1 Telemetry Format at:

http://www.camsat.cn/index.php?option=com_phocadownload&view=category&id=1:xw-1&download=1:xw-1-telemetry&Itemid=66

The XW-1 store-forward transponder user's manual can be found on the AMSAT Web at: http://www.amsat.org/amsat-new/satellites/documents/XW-1_Store-forward_Transponder_Users_Manual.pdf

Details of the XW-1 satellite are available at:

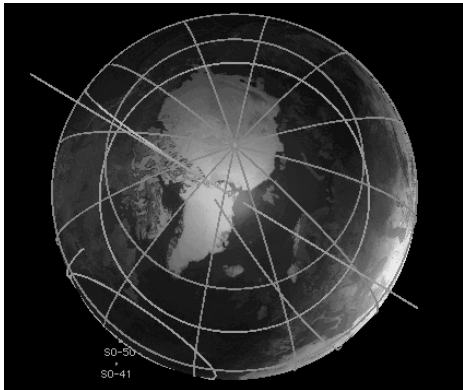
http://www.camsat.cn/index.php?option=com_content&view=article&id=56&Itemid=67 ☎

The graphic features a large '4' with '1969' above it and '2009' below it, followed by 'YEARS'. The text 'AMSAT' is in a large, bold, sans-serif font. Below this, it says 'OF AMATEUR RADIO IN SPACE'. At the bottom, it reads 'AMSAT cordially invites you to help us celebrate our 40th anniversary'. The date 'October 9, 10, and 11th at the Four Points Sheraton Hotel Baltimore - Washington Airport' is at the very bottom. The background is a light gray with a subtle pattern of radio waves and a satellite dish.



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A Survey of CubeSat Communication Systems

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Abstract

This paper provides a short summary of the communication subsystems on CubeSats in orbit today and compares their on-orbit performance. Frequencies, modulation schemes, antennas and power outputs are discussed. Commercial off the shelf (COTS) transceivers, modified and unmodified and custom-built transceivers are compared and contrasted. Recommendations for the communication subsystems of new CubeSat projects are presented. In this first part the overall communication system design goals are discussed. The most recently launched fleet of CubeSats is discussed.

Introduction

This paper discusses the communications subsystems on CubeSats in orbit today, clearly showing that the communication system is one major limiting factor for CubeSats. We provide background information on the CubeSat project and describe how the Amateur Radio and CubeSat communities work together. Next we discuss the common transceiver configurations, including purchasing a COTS transceiver, purchasing then modifying a COTS transceiver and custom-built transceivers. We give some recommendations to new CubeSat developers building a communications subsystem. We will provide a description of the most recently launched CubeSats as most are still operational.

CubeSat Standard

The CubeSat standard started as a joint project between Cal Poly State University and Stanford University in 1999[1]. Cal Poly Professor Dr. Jordi Puig-Suari and Stanford Professor Bob Twiggs imagined multiple 10 cm cubes in a jack-in-the-box type launcher after their experience building and deploying picosatellites from the Orbiting Picosatellite Automated Launcher (OPAL), a 23 kg nanosatellite. Each picosatellite's mass is less than 1 kg, or the equivalent of a 10 cm cube of water [2]. While many criticize this standard as being "too small to do anything," universities and industry have shown that a lot of science and data collection is possible with these picosatellites. Novel new electronics, such as cheap cameras, processors and sensors gain space ratings by flying in a CubeSat.

CubeSat Launches

Access to space constitutes the largest hurdle for universities building small satellites. While many satellites launch every year, the primary payload usually does not allow universities to attach anything to their rocket due to concerns that this addition might possibly harm the primary payload. The Poly Picosatellite Orbital Deployer (P-POD) mitigates this fear by placing a strong protective box around the secondary payloads and thoroughly testing satellites for structural strength. Variants of the P-POD include the University of Toronto's X-POD and by the University of Tokyo's T-POD, both of which have flown. This accessibility problem, and the fact that foreign launches are so much cheaper, forces most CubeSats to use foreign launch vehicles. To date, 23 CubeSats have flown on 5 foreign launch vehicles, and one CubeSat has flown on a US launch vehicle. Non-US launches present an ITAR problem and some universities have become entangled in this issue before clearing it up with the State Department.

Amateur Radio Involvement

To a few in the Amateur Radio community all of these CubeSats just steal frequencies and don't benefit the community at all. However, most of the teams provide clear benefits to the Amateur Radio community, including more licensed hams, new modulation schemes and modes, increased awareness of the issues challenging Amateur Radio today, international collaboration, and education of a new generation of Amateur Radio operators. These new hams are the future of the Amateur Radio hobby and will steer the hobby in new directions while fighting against new threats to the hobby [3].

At Cal Poly State University, students are encouraged to obtain their Amateur Radio license so they can communicate with satellites without a control operator. Approximately 70% of the students working on the CubeSat project acquired their Amateur Radio license while on the project, and many use their license for terrestrial communications. It seems that countries outside North America are more generous to the Amateur Radio community. The University of Tokyo allows ordinary hams in Japan to use XI-IV for taking pictures of

the earth after their newer XI-V satellite was launched in October 2005. More recently, the Delfi-C3 team turned on their linear transponder. Stations across the world used CW or SSB through this low-power transponder while it was operational.

Common Transceiver Configurations

Arguably, one of the most important parts of any satellite is the communications subsystem. Without any way to communicate, the CubeSat would quickly become space junk. When selecting a communications subsystem for a CubeSat, three possibilities exist: buying a COTS transceiver, purchasing one designed for terrestrial use and modifying it, or building a transceiver from individual components.

COTS

Purchasing a COTS space-rated transceiver simplifies the design of the subsystem. Purchased transceivers typically accept standard serial data and perform all of the packetization, error checking and retransmission. Most of the protocols and modulations are proprietary and device-specific, requiring an identical radio at the command ground station and ruling out any large-scale ground station network. Several companies build space-rated transceivers, but usually they are too expensive, heavy and big for a CubeSat. The Stensat Group builds a transceiver specifically for CubeSats, with a 2 m receiver and 70 cm transmitter. Libertad-1 proved that the transmitter works in space [4]. Two new small companies, AstroDev and ISIS, recently began selling radios designed for CubeSats.

Modified COTS

Designed for use on earth, many COTS transceivers would have serious problems functioning in space. A significant problem with commercial transceivers includes active thermal dissipation, as no air exists for convective cooling of the amplifiers. Required modifications for use in space include removing the case to reduce mass and size, drilling mounting holes, increasing transmit power, programming the transceiver to operate after power cycling, removing LCD displays and buttons and changing the

continued on page 25 ...



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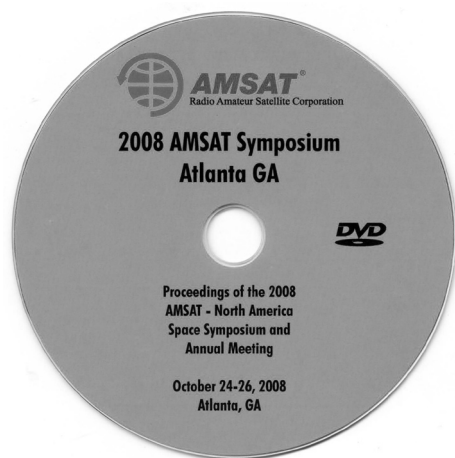
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spread-spectrum timings to allow the radios to get a lock 3,000 km away. Some of these modifications require assistance from the manufacturer. Microhard Systems builds a 2.4 GHz transceiver that has flown on several missions. However, it is extremely difficult to deal with and unsuitable for 1U CubeSats, requiring a very large dish to close the link. The receiver alone requires 1.1 watts of DC power [5, 6]. Other transceivers flown on CubeSats in space include the Alinco DJ-C4 and DJ-C5.

Custom-Built

Some projects, mainly those built by universities, decide to build the entire transceiver out of individual components. Building a custom communications subsystem allows tighter control of requirements and specifications, and encourages the next generation of students to learn about building small RF circuits. However, these transceivers have been less successful due to the inherent difficulties in RF board design.

Components of these custom-built transceivers include the terminal node controller (TNC), transceiver, and amplifier. Typically, the TNC consists of a microcontroller such as a Microchip PIC. Sometimes this same microcontroller also interfaces with the transceiver to program register settings during startup. Single-chip transceivers for the 433 MHz band perform well in the UHF amateur satellite band. Common manufacturers for such chips include Texas Instruments, RF Microdevices, and Analog Devices. Other universities go even further than this by building their entire transceiver

at the transistor level, as is the case with Delfi-C3.

Satellite Comparison

Table 1 shows a summary of the different communications subsystems of the satellites. Only downlink frequencies are listed.

PSLV-C9 Launch

The first CubeSat launch from India, the Polar Satellite Launch Vehicle launched on April 28, 2008 with 10 satellites aboard, including two large satellites, two nanosatellites, and six CubeSats. The rocket weighed 230 tons, or almost 50 elephants, and launched from Chennai, on the country's east coast. The rocket went into a 635 km polar orbit at 97.9 degrees [7].

Integration into the X-PODs occurred in Toronto in the middle of August 2007. The teams arrived in India at the beginning of April 2008 and began getting the satellites and X-PODs ready for launch vehicle integration. One launch complex employee continuously swept and vacuumed the clean room floor. The launch went flawlessly and all CubeSats on this launch continue to work in November 2008.

Delfi-C3 (DO-64)

The first CubeSat built by students at Delft University of Technology, Delfi-C3 contains two payloads. Thin film solar cells, donated by Dutch Space for flight testing, reside on the end of the solar panel deployables. Autonomous wireless sun sensors, located on each end and using a 915 MHz Nordic nRF9E5 for communication to the bus, provide attitude determination and are flown for flight qualification. The communications subsystem of this satellite contains a custom-built BPSK telemetry transmitter and a linear transponder, both technologies flying for the first time on a CubeSat [8]. The satellite contains 17 Microchip PIC18LF4680 microprocessors for all the various subsystems [9].

This satellite contains no batteries, so this satellite resets once per orbit. The on-board computer

and command uplink receivers are always on when in the sunlight. The team thoroughly tested the spacecraft's boot-up sequence, but even with all the testing the satellite sometimes abruptly turned off the downlink due to a non-critical data bus issue. This issue was worked around with an on-orbit software update.

This spacecraft contains two radios, each containing a command uplink receiver and BPSK telemetry transmitter. One radio also contains a linear transponder that shares the IF stage with the BPSK system.

The telemetry transmitter consists of an entirely custom built 1200 baud BPSK transmitter. The team selected the BPSK modulation scheme because of the lower signal-to-noise ratio requirements and ease of decoding with a computer sound card. It uses the standard AX.25 packet format. The BPSK signal is generated in a double-balanced mixer with shaped bits, similar to the method used on AO-16 [11, 12].

The Delfi-C3 team released telemetry decoding software, RASCAL, which allowed regular Amateur Radio operators to decode this new modulation scheme. The RASCAL software listened to the computer's sound card and graphically represented satellite health with gauges. The software also forwarded this data to Delfi-C3 Mission Control, and allowed the team to get an almost real-time status of the spacecraft around the world. This software excited many hams, who forwarded more than 60 MB of telemetry to the team. Since this satellite does not contain on-board



Figure 1: PSLV C9 during liftoff.

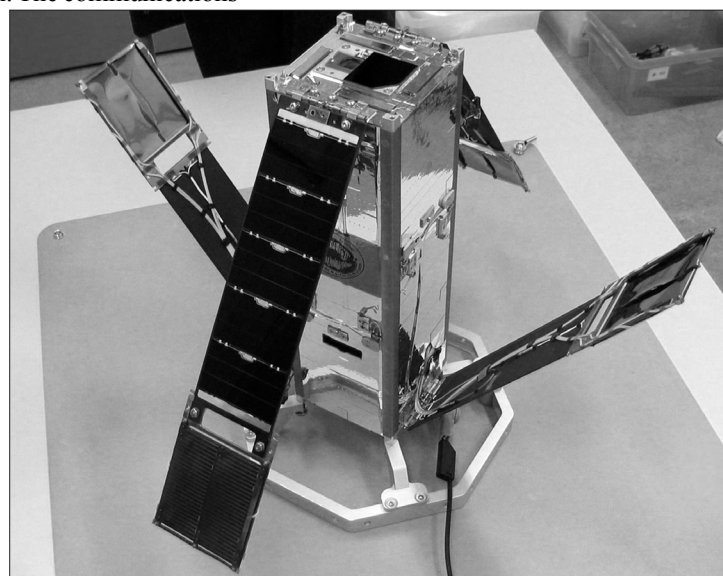


Figure 2: Delfi-C3 after thermovac [10]. The wireless sun sensor resides on the top and bottom, and the thin film solar cells are separated at the ends of the deployables.

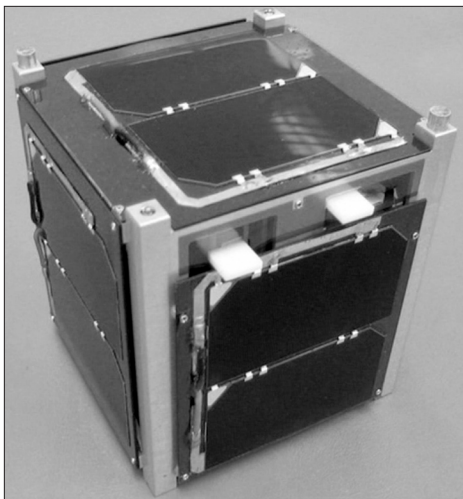


Figure 3: Seeds-2

telemetry storage, this distributed ground station network is crucial for the Delfi-C3 team to understand the health of the satellite and gather payload data.

When in transponder mode, the satellite acts just like a very low power linear transponder. The satellite transmits a CW beacon 10 kHz lower than the passband, at 10 dB down from the main signal. With a similar message to the original Sputnik satellite, the CW beacon uses double sideband modulation. Be sure to use a good ground station, as the hearing-challenged satellite transmits only 400 mW. During the annual AMSAT-UK Colloquium at the University of Surrey in July 2008, the Delfi team permanently placed their satellite

in transponder mode. When this mode was active, ordinary Amateur Radio operators used the spacecraft for SSB and CW contacts, although the very low power of the transmitter made it difficult for weak or deaf stations. During the Colloquium, several ordinary amateurs made contacts through the satellite, but the hand-held stations at the Colloquium didn't have enough power to use the transponder for voice contacts.

SEEDS-2 (CO-66)

Originally developed for the Dnepr Launch 1 in September 2004, this first satellite from Nihon University contains several sensors and a Digi-Talker as the primary payload, similar to FO-29 [13]. The sensors include 3-axis gyros and magnetometers. When the Dnepr 1 launch failed, the team upgraded the extra engineering unit to flight status and added slow-scan TV (SSTV) functionality to the Digi-Talker.

This satellite contains one transmitter and one receiver, built by Musashino Electric Machine Ltd., each with their own separate monopole antennas [14]. When transmitting CW, the output power is 90 mW, and the FM Digi-Talker/SSTV transmitter output is around 450 mW. Many people around the world received and decoded the SSTV transmissions [15].

The Nihon University ground station contains four phased UHF antennas for downlink and one VHF Yagi for uplink, and an ICOM

910D transceiver. The station, along with 12 other university stations, also participate in the Japanese Ground Station Network. The ground station has downloaded 500 kB of data [16].

CanX-2

The second CubeSat from The University of Toronto's Space Flight Laboratory, CanX-2 tests critical technologies for future CanX satellites. Developed in 2 years, this satellite includes experiments such as propulsion, imagers, attitude determination and GPS [17]. The main processor consists of a 12 MHz ARM7.

This satellite contains a UHF command transceiver. It operates with a 4 kbps GMSK modulation scheme in the 70 cm Amateur Radio band using a canted quad antenna system. The UHF transmitter portion has never been turned on because the S-band transmitter works much better. The primary downlink consists of a custom built S-band transmitter. It puts out 500 mW with a BPSK or QPSK modulation scheme. The data rate is variable between 8 kbps and 1.024 Mbps, but their license restricts the signal bandwidth to 500 kHz, or a maximum of 256 kbps. Early plans included a VHF transmitter, but this was scrapped due to space constraints. CanX-2 uses the Nanosatellite Protocol (NSP), a custom protocol with flight heritage from their earlier MOST space telescope mission [19].

CanX-2 uses the licensed Space Research spectrum between 2200 and 2290 MHz. The Canadian Radio-television and Telecommunications Commission and International Telecommunications Union coordinates these frequencies and it took 4 years for the team to obtain a frequency. The ground station consists of a tripod with dual phased UHF high-gain Yagis, and a tower with a single VHF Yagi and 2.1 meter dish with S-band feed [20].

AAUSAT-II

AAUSAT-II is the second satellite from Aalborg University, Denmark. AAUSAT-II's primary mission is to space test a gamma radiation detector from the Denmark National Space Institute. The main processor consists of an ARM7 Atmel AT91SAM7A1, operating at around 60°C. Currently, the satellite produces a lot of power, spins around 30 RPM, and the main computer reboots every one to four hours [21].

AAUSAT-II uses a custom-built transceiver from Holger Eckhardt. A PIC18LF6680

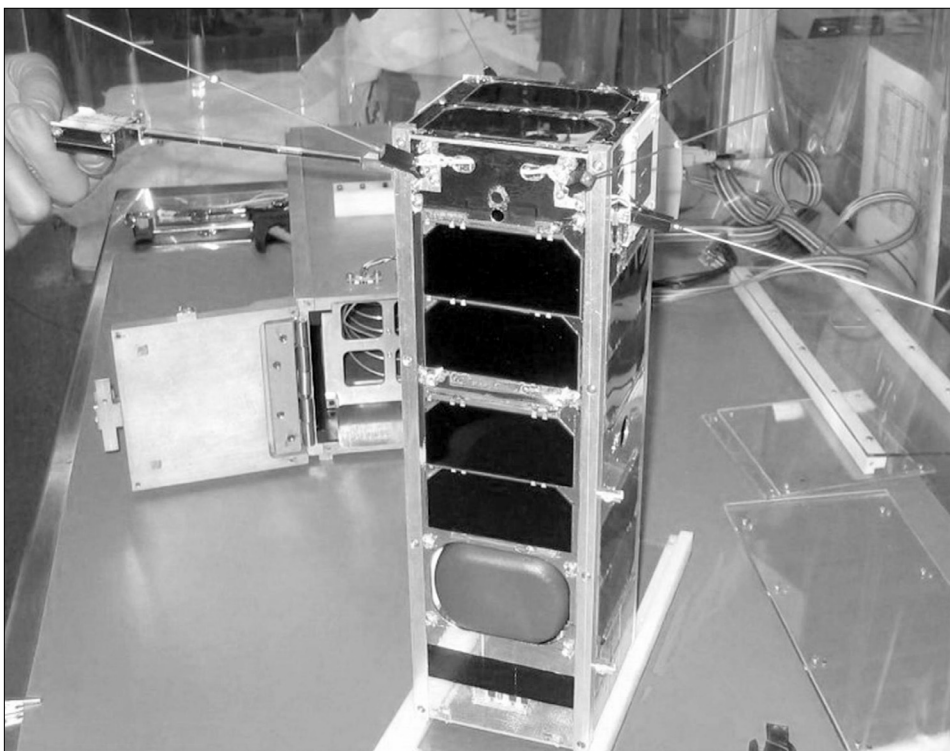


Figure 4: CanX-2 with the X-POD in the background [18].

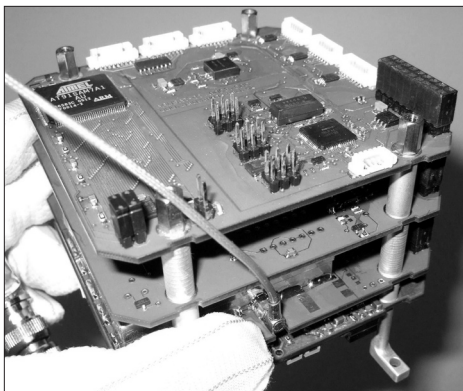


Figure 5: AAUSAT-II

performs data packetization and sends the data to the modem chip via USART. The modulation scheme is MSK, generated by a CML Microcircuits CMX469A chip. This chip can be configured to work at either 1200, 2400, and 4800 baud, although the system defaults to 1200 baud [22].

After launch, the team noticed that the satellite was not hearing the ground station at all. Two months after launch the team finally communicated with their satellite with a borrowed 400 watt amplifier. Shortly after they established contact with their spacecraft, it was apparent that it was rotating very quickly, around 24 rpm, and slowly increased to 60 rpm over the next month and a half. It is unclear what caused the increasing rotation, but some speculate that a short in a loop of wire around one solar panel is torquing the spacecraft. The rate slowed considerably after the team turned on the internal de-tumbling algorithm [23].

The university's ground station consists of two phased medium-gain Yagis. After establishing contact with the 400 watt amplifier, the team purchased a 1 kW amplifier and has not had uplink problems



Figure 6: Cute 1.7+APD 2.

since.

Cute 1.7+APD II (CO-65)

Cute 1.7+APD II is the third picosatellite from the Laboratory for Space Systems at the Tokyo Institute of Technology. The immediate successor to Cute-1.7+APD, this satellite shares a lot of the same design as its predecessor, including the same Avalanche Photo Detector (APD) payload. The main processors, inside the dual Hitachi NPD-20JWL PDAs, are a 400 MHz ARV4I.

This satellite, however, incorporates several improvements based on lessons learned from the Cute 1.7+ APD flight experience. This satellite differs from Cute 1.7+APD in three main ways [24]. First, the team redesigned the satellite with radiation-tolerant parts to protect the onboard computers from single event latch-ups, possibly the cause of the previous spacecraft's communications failure. Second, the team modified the structure to decrease satellite integration time.

The third improvement included addressing the lack of electrical power available onboard by increasing the size of the satellite to allow for more solar cells. This increase in surface area, to a volume of 11.5 cm x 18 cm x 22 cm, meant that the spacecraft would not fit inside the P-POD or X-POD, so the university built a custom separation mechanism. The communications subsystem did not change between the previous satellite and this one [25].

The ground station at Tokyo Institute of Technology has downloaded about 7 MB of data, and the Japanese GSN has collected about 5 MB of data. Ordinary Japanese Amateur Radio operators have forwarded about 9 MB of data to the university, bringing the total collected data to around 21 MB. However, this figure includes duplicated data, so the actual number may be significantly less [26].

Compass-1

Started in 2004, this CubeSat from the Aachen University of Applied Sciences, Germany, contains a 640 x 480 pixel Omnivision camera for taking pictures of the earth. A Phoenix GPS from the German Space Center and sun sensors control active magnetorquers to orient the spacecraft when the camera takes pictures. The main processor is an Infineon C8051F123 from Silicon Laboratories [27].

This satellite contains one transceiver, custom built by Holger Eckhardt, and one CW

transmitter. To receive, a Mitel MT88L70 DTMF decoder chip listens for VHF uplink commands. During transmission, a Silicon Laboratories C8051F123 packetizes the data from the main processor. The radio can send 1200 baud AFSK using a FX614 modem chip. When commanded, it can send 2400 or 4800 baud MSK using a CMX469A modem chip with the AX.25 packet format.

The CW beacon transmitter uses a custom-built circuit around a BC549 transistor. The output power is about 200 mW. When the satellite started beaconing for the first time, many listeners immediately noticed a large amount of chirp on the signal. This chirp is caused by the on/off switching of the transmitter, which causes the crystal to change it's frequency during transmission. Both Compass-1 and Cute-1.7+APD II share the same beacon frequency, so just after launch one could hear both satellites transmitting at the same time [28].

In September 2008, Compass-1 began having power problems. The satellite tried to heat the batteries constantly, but the batteries could not supply the heater current and the spacecraft shut off once per orbit. The team released the uplink codes to the amateur community with the hopes that somebody could change the temperature set points before the satellite shut down. This attempt succeeded and the spacecraft operates normally today.

The ground station consists of two phased 2 m Yagis and four phased 70 cm Yagis from Tonna, with ICOM IC-910H and IC-821H radios. Mike Rupprecht, DK3WN, also helps out with his ground station. The Compass-1 team also operates a ground station in Taiwan [29].

Communications Subsystem Recommendations

Based upon accumulated experience with

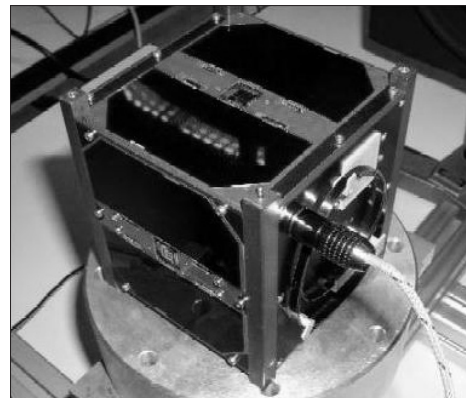


Figure 7: Compass-1.

several CubeSats, we recommend that new satellite developers follow these guidelines:

- Include a long-running beacon. All Japanese CubeSats are easy to track because they contain CW beacons that operate almost continuously. While the beacons are very low power, on the order of 100 mW RF power, they are easily received by a common SSB receiver and an omnidirectional whip antenna. Include as much spacecraft data on this beacon as you can so that you learn about your satellite even if uplink does not work.
- Use "common" amateur modes for data communication. After the CP4 launch, several radio amateurs around the world tracked our spacecraft on every pass. These amateurs, including Mike Rupprecht in Germany and Colin Hurst in Australia, forwarded all packets to our ground station, tremendously increasing our knowledge of our satellite. Colin Hurst even wrote up a complete attitude determination paper for CP4 [30].

However, there are downsides to using common modes. The common 1200 baud data rate is too slow for large amounts of data, the AFSK modulation scheme requires a large signal-to-noise ratio, and there is no forward error correction or compression in the AX.25 protocol. The CubeSat and Amateur Radio communities need to coalesce around a new "common" mode, one that emphasizes spectral efficiency, data rate, and error correction, and is ideally supported by multiple commercial vendors.

- Include a simple reset in case the satellite becomes non-responsive. QuakeSat-1 ground operators used a simple DTMF code several times to rescue the locked-up satellite. If CP4 contained a command to fully reset the satellite, we might be able to reset the processor and start normal operations again.
- Verify your ground station early. Several universities launched satellites without functioning ground stations. There is no reason to launch a satellite if you can't communicate with it! Test your ground station by talking to other Amateur Radio operators through a satellite. Listening to beacons lets you

test the ground station receiver, but does not verify the transmitter. A great opportunity for CubeSat developers at universities to network occurs on College Night on AO-51, twice a month on Thursdays during the evening passes.

- Don't depend on another ground station to close your communications link. The MAST team couldn't talk with their satellite for three days because another satellite group had booked the dish they needed. This lack of communication with the dish operators probably caused the mission to fail. Each organization building CubeSats should have full unrestricted access to a local ground station, ideally situated in the same building as the satellite development lab.
- Get an AMSAT mentor. If your project intends to use Amateur Radio frequencies, mentors are invaluable resources when you're trying to learn about the Amateur Radio Service. Most mentors know a lot about electronics and RF systems. They can tell you exactly how to build a ground station and will usually allow their station as a back-up in case the primary ground station fails during operations. Mentors can be found by contacting local AMSAT groups directly.

Conclusion

Table 1 shows the low data rates on CubeSat downlinks in orbit right now. Overall, around 797 MB of data have been downloaded from 24 CubeSats over 5 years. Without QuakeSat-1 and CanX-2, the data download drops to around 124 MB over 5 years. This is a very small number, highlighting the need for a good transceiver capable of fitting within the CubeSat form factor and weight/power constraints.

An ideal radio designed for CubeSats does not exist at this time. However, there are several transceivers that have successfully flown in space and returned large amounts of data to earth. Some of those radios are commercially available.

The CubeSat and Amateur Radio communities also need to jointly develop and agree on a new "common" modulation scheme, with larger data throughput and forward error correction. This standard modulation scheme will allow amateurs and universities to easily track each others'

spacecraft and forward data.

Some groups are trying to combat this data deficiency by networking many ground stations, similar to the ground station in Alaska for QuakeSat-1 but over a much larger scale. The Global Educational Network for Satellite Operators (GENSO) project aims to link hundreds of low-cost Amateur Radio ground stations via the Internet [31,32]. It will also allow remote control of satellites from ground stations around the world, greatly increasing satellite health knowledge. GENSO was scheduled to be open to any interested parties in summer 2009.

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Table 1 appears on the next page ...

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Table 1: CubeSat Summary (✓ indicates currently active)

On Air	Satellite	Size	Radio	Frequency (MHz)	License	Power	TNC Protocol	Baud Rate Modulation	Antenna
✓	AAU1 Cubesat ¹	1U	Wood & Douglas SX450	437.475	Amateur	500 mW	AX.25, Mobitex	9600 GMSK	Dipole
	DTU sat-1	1U	RFMD RF2905	437.475	Amateur	400 mW	AX.25	2400 FSK ¹	Canted Turnstyle
	CanX-1	1U	Melexis	437.880	Amateur	500 mW	Custom	1200 MSK ¹	Crossed Dipoles
✓	Cute-1	1U	Maki Denki (Beacon)	436.8375	Amateur	100 mW	CW	50 WPM	Monopole
	CO-55	3U	Alinco DJ-C5 (Data)	437.470	Amateur	350 mW	AX.25	1200 AFSK	Monopole
	QuakeSat-1	3U	Tekk KS-960	436.675	Amateur	2 watts	AX.25 (Pacsat)	9600 FSK	Turnstyle
✓	XI-IV	1U	Nishi RF Lab (Beacon)	436.8475	Amateur	80 mW	CW	50 WPM	Dipole
	CO-57	1U	Nishi RF Lab (Data)	437.490	Amateur	1 watt	AX.25	1200 AFSK	Dipole
✓	XI-V	1U	Nishi RF Lab (Beacon)	437.465	Amateur	80 mW	CW	50 WPM	Dipole
	CO-58	1U	Nishi RF Lab (Data)	437.345	Amateur	1 watt	AX.25	1200 AFSK	Dipole
	NCube-2 ²	1U		437.505	Amateur		AX.25	1200 AFSK	Monopole
	UWE-1	1U	PR-430	437.505	Amateur	1 watt	AX.25	1200/9600 AFSK	End-Fed Dipole
✓	Cute-1.7+APD I	2U	Alinco DJ-C5 (Telemetry)	437.385	Amateur	100 mW	CW	50 WPM	Dipole
	CO-56	3U	Atmel AT88402 (Beacon)	437.505	Amateur	300 mW	AX.25/SRL	1200 AFSK/9600 GMSK	Dipole
	GeneSat-1	3U		437.067	Amateur	500 mW	AX.25	1200 AFSK	Monopole
	CS1B1	1U	Microhard MHX-2400 Commercial ⁴	2.4 GHz 400.0375	Experimental	1 watt < 1 watt	Proprietary Proprietary	1200 AFSK	Patch Dipole
	AeroCube-2	1U	Commercial ⁴	902.928	ISM	2 watts	Proprietary	38.4 K	Patch
	CP4	1U	TTCC1000	437.325	Amateur	1 watt	AX.25	1200 FSK	Dipole
	Libertad-1	1U	Stensat	437.405	Amateur	400 mW	AX.25	1200 AFSK	Monopole
	CAPE1	1U	TTCC1020	435.245	Amateur	1 watt	AX.25	9600 FSK	Dipole
✓	CP3	1U	TTCC1000	436.845	Experimental	1 watt	AX.25	1200 FSK	Dipole
	MAST	3U	Microhard MHX-2400	2.4 GHz	ISM	1 watt	Proprietary	15 Kbps	Monopole
✓	Deft-C3	3U	Custom Beacon	145.870	Amateur	400 mW	AX.25	1200 BPSK	Turnstyle
✓	DO-64	1U	Custom Transponder	145.9435.55	Amateur	200 mW	Linear XPNDR	40 KHz BW	Turnstyle
	SEEDS-2	1U	Mushashino (Beacon)	437.485	Amateur	90 mW	CW		Monopole
✓	CO-66	3U	Mushashino (Data)	437.485	Space	450 mW	AX.25	1200 AFSK	Monopole
	CanX-2	3U	Custom S-band	2.2 GHz	Research	500 mW	NSP	16-256 Kbps BPSK	Patch
✓	AAUSAT-II	1U	Holger Eckhardt DF2FQ	437.425	Amateur	610 mW	AX.25	1200 MSK	Dipole
✓	Cute-1.7+APD II ³	3U	Invax (Beacon)	437.275	Amateur	100 mW	CW	50 WPM	Monopole
	CO-65	1U	Alinco DJ-C5 (Data)	437.475	Amateur	300 mW	AX.25/SRL	1200 AFSK/9600 GMSK	Monopole
✓	Compass-1	1U	BC549 (Beacon)	437.275	Amateur	200 mW	CW	15 WPM	Dipole
			Holger Eckhardt (Data)	437.405		300 mW	AX.25	1200 AFSK/MSK	Dipole

1. Satellite was never heard from when in space.
2. This object separated from SSETI Express months later and is presumed to be NCube-2.
3. This satellite is larger than a CubeSat spacecraft but design is based upon earlier CubeSat designs.
4. Manufacturer and model unknown.

AMSAT BoD Telecon**November 3, 2009****Called to order by Barry Baines,
WD4ASW at 20:10 EST****Attending:****Directors**

Barry Baines, WD4ASW
 Gould Smith, WA4SXM
 Drew Glasbrenner, KO4MA
 Lou McFadin, W5DID
 Bill Ress, N6GHZ
 Alan Biddle, WA4SCA
 Tony Monteiro, AA2TX (Alternate)
 Tom Clark, K3IO (Joined meeting in progress.)

Others:

Martha Saragovitz, Manager
 Gunther Meisse, W8GSM Treasurer

Gunther discussed some technical category adjustments to the budget. Reporting on expectations for 2010, with the planned \$100 k fundraising effort, the expected profit should be \$210 k. We need to emphasize to the members that the CubeSat project is separate from the President's Club so that we are not simply reallocating the same funds. Lou expressed concern that work on ARISSat-1, expected to be done this year, was extending into 2010. Also, basic ARISS projects were not yet funded for 2010. This was discussed, with budgeting for ARISSat-1 and ARISS to be split off into two separate categories. Gould moved and Drew seconded that the budget be approved preliminarily, to be reviewed if needed. The vote was unanimously in favor.

Lou had expressed a desire for AMSAT-NA to institute a student rate to recruit and hold younger members, especially those working on university projects. A motion was developed, read by Alan.

Motion:

In order to expand its educational outreach efforts, AMSAT-NA establishes a student category of membership. The yearly rate will be half the standard applicable rate, and shall be available to all students in primary and secondary school. Post-secondary school students enrolled in at least half time status shall be eligible for a maximum of 6 post-secondary years in this status. In addition, the student membership application should indicate:

- 1) School attending.
- 2) Course of study.
- 3) Expected graduation date.

There was a brief discussion about the details of the application form, especially with respect to elementary students, and it was considered to be reasonable. Alan moved and Lou seconded that the student rate be approved. The vote was unanimously in favor. Bill stated he would write something for the *Journal*.

Gould discussed the ongoing development of an Acceptable Use Policy for the AMSAT bulletin board. Substantial progress has been made, especially in simplification, but it is not ready for final consideration. Barry mentioned the issues resulting from the AMSAT-HISS settlement on bulletin board operation. The sense of the board was to allow time for future development of the AUP.

Bill emphasized the need to move along with the CubeSat, even though ARISSat-1 is currently consuming available technical resources. Selecting a working name will be necessary for the upcoming fundraising effort. After discussing possible ways to select and possibly merchandise the name, Tom stepped in with a review of past naming traditions and practices. Based on these, the pre-launch working name should be "Fox." This was informally accepted by the board. Keith Baker, K1BSF has expressed an interest to Barry about working with the publicity and fund drive. Barry will contact him to gain his concurrence on the proposed project name.

Bill Tynan, W3XO, has circulated a draft petition to the FCC concerning satellite operations involving college students and faculty controlling the control of satellites they have built. Tom noted that the FCC and ARRL have recently become heavily involved with issues involving paid staff and EMCOMM and that this might not be the best time to make waves. Since Bill Tynan was unable to attend the telecon, it was decided to postpone the discussion.

Gould gave the board an update on ARISSat-1. The recent NASA review brought up very few issues. At the latest Phoenix meeting report is that while the hardware is in general in good shape, that more testing is needed on the IHU and power systems. Barry summed up the primary uncertainties as testing by AMSAT, and the final AMSAT safety review, most likely in January or February, 2010. Currently the existing ARISSat-1 delivery is on schedule for late December.

Barry will be meeting with the Education

Office at the Johnson Space Center next week. This meeting will cover a wide range of issues, and will give a better understanding of the current NASA perspective on Amateur Radio operation as well as give JSC Education an overview of AMSAT.

During the next week Perry Klein, W3PK, will be meeting informally with Bob Twigg, KE6QMD, to discuss various matters of common interest. Others will be attending this meeting, though there is no formal list. Tom mentioned that especially at such informal meetings, we need to be very aware of ITAR issues, as well as the fact that other attendees may well have significantly different primary interests.

Barry ended the meeting with several brief items. The storage pod at HISS is now empty, well before the deadline. We are currently awaiting clearance from both attorneys for an AMSAT News Service release on the settlement. There is still no response from the Department of State concerning our request for clarification of some ITAR issues. Bob McGwier, N4HY, is in discussion with the Electronic Freedom Foundation concerning an individual action.

Drew moved and Barry seconded that the meeting be adjourned. The motion was carried unanimously.

The official board meeting was closed at 21:27 EST.

Submitted by,

Alan Biddle, WA4SCA

2009-2010 AMSAT Secretary



Reach for the stars.

N3UC, formerly N4USI, control operator of AO-27, says, "AO-27 may be getting old and failing at times, after 15 years circling the earth. But, my IC-910H that I use to control AO-27, using data transmissions, has never failed me".

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